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ELECTRICAL SECTION.

(*Concluded from vol. clxi, page 142*)

Electrochemical Calculations.

BY JOSEPH W. RICHARDS.

POTENTIAL FOR MIXED ELECTROLYSIS.

The above data are easily applied when the current is doing only one thing, *i. e.*, is separating out or dissolving only one element. But in many cases the current is causing a compound anode to dissolve, as when copper and silver both dissolve from a silver bullion anode; or two or more metals may be simultaneously deposited, as when copper and zinc are deposited together as brass. In all such cases, the simplest procedure is to foot up the thermochemical energy of the total electrochemical change for any given time or number of

coulombs passing. Then express this per 96,540 coulombs passing, and divide by 23,040; the quotient will be V^d

$$\text{Voltage drop } (V^d) = \frac{\text{Q for 96,540 coulombs passing}}{23{,}040}$$

Example: An electrolyte contains zinc sulphate with some copper sulphate, and is electrolyzed with a copper anode. There is deposited upon the cathode in one hour 15 grams of brass, containing one-third zinc and two thirds copper. What voltage drop will occur in the cell in addition to that necessary to overcome its ohmic resistance?

Solution: The coulombs passing are those necessary to deposit 5 grams of zinc (chemical equivalent 65÷2) and 10 grams of copper (chemical equivalent 63.6÷2)

$$\text{Coulombs for zinc} = \frac{5.0000}{0.00001035 \times (65 \div 2)} = 14{,}864$$

$$\text{“ “ copper} = \frac{10.0000}{0.00001035 \times (63.6 \div 2)} = 30{,}383$$

$$\text{Sum} = 45{,}247$$

The weight of copper dissolved will be, on the same principles—

$$45{,}247 \times 0.00001035 \times (63.6 \div 2) = 14.892 \text{ grams.}$$

The solution of 14.892 grams of copper and deposition of 10 grams of the same element, shows that the only thermochemical energy required is that absorbed for the solution of 4.892 grams of copper and deposition therefor of 5.0 grams of zinc. The thermochemical equation is—

$$\underset{-248{,}000}{Zn\,SO^4aq} + Cu = \underset{+197{,}500}{Cu\,SO^4aq} + Zn \quad = -50{,}500 \text{ calories,}$$

Showing that 50,500 calories is absorbed for every 65 grams of zinc (its atomic weight) thus deposited. This equals an absorption of 3,885 calories per 5 grams of zinc, or for the whole period, during which 45,247 coulombs passed through the cell. For every 96,540 coulombs passing, the thermochemical heat absorption is

$$\frac{3{,}885}{45{,}247} \times 96{,}540 = 8{,}289 \text{ calories.}$$

and the voltage drop is

$$V^d = \frac{8{,}289}{23{,}040} = \underline{0.36} \text{ volt.}$$

The above calculation is on the assumption that the copper and zinc deposit separately, as mixed crystals. If they really deposit as a chemical combination, the heat of formation of the alloy would need to be considered also in the above calculation.

The main point sought to be emphasized by the foregoing statements and illustration is that the current may, and very often does, do two kinds of chemical work simultaneously, requiring, if each alone took place separately, different drops of potential to accomplish the chemical work; in such cases, the only safe ground is to say that the coulombs passing must furnish the sum total of all the energy for all the chemical changes induced at the electrode surface, and therefore must drop sufficiently in potential to furnish the energy required (in addition, of course, to the ordinary drop of potential caused by the ohmic resistance of the bath).

CURRENT FOR MIXED ELECTROLYSIS.

When the current is dissolving or depositing only one element, the calculation of the quantity of material concerned with a given transfer of electricity is a simple question: The Faraday, 96,540 coulombs, dissolves or deposits one chemical equivalent weight in grams.

If, however, two or more elements are simultaneously dissolved or deposited, as occurs frequently in metal refining or plating, the calculation is not so simple. The proper procedure in that case is to find how many coulombs are required for the separate weights of each element dissolved or deposited, and add these together to obtain the total current needed. Or, if the current used is given, and the question is the amounts of mixed metals dissolved or deposited, obtain the coulombs necessary to dissolve or deposit one kilogram of the alloy or mixed metals, and divide this into the total coulombs used.

Example: In the Wohlwill process of refining gold bullion, the anodes consist of 80 per cent. gold, 8 per cent. silver, 10 per cent. copper and 2 per cent. platinum. One hundred and fifty amperes pass through each cell, attacking or corroding the anodes uniformily, while the silver deposits at the bottom of the bath as Ag Cl, gold is deposited pure on the cathodes, and platinum and copper accumulate in the solution at $Pt Cl^4$ are—$Cu Cl^2$ respectively.

Required: (1) How much weight of anode is corroded per twenty-four hours?

(2) How much more gold is deposited than is dissolved?

(3) What voltage of decomposition, to represent chemical work, must be furnished?

Solution: (1) One kilogram of anode contains—

Gold.....	800 grams
Silver.....	80 "
Copper.....	100 "
Platinum.....	20 "

The coulombs necessary to dissolve these weights, to to convert these metals into $Au Cl^3$, Ag Cl, $Cu Cl^2$ and $Pt Cl^4$ are—

Gold.....800÷(0.00001035×197 ÷3)=	1,177,076	coulombs.
Silver.... 80÷(0.00001035×108 ÷1)=	71,570	"
Copper...100÷(0.00001035× 63.6÷2)=	303,831	"
Platinum.. 20÷(0.00001035×195 ÷4)=	39,638	"
	1,592,115	"

Coulombs available, per 24 hours

$$150\times60\times60\times24=12{,}970{,}000$$

Anode corroded away in 24 hours, per cell

$$12{,}970{,}000\div1{,}592{,}115=8.146 \text{ kilograms}$$
$$=8{,}146 \text{ grams} \quad (1)$$

(2) The weight of gold deposited, by the total current, is

$$12{,}970{,}000\times(0.00001035\times197\div3=)=8{,}815 \text{ grams.}$$

Amount dissolved, 8,146×0.80	=6,717	"
Shortage in each cell, per 24 hours	=2,098	" (2)

This shortage, it will be recalled, has to be made up by dissolving some of the bullion in acid, and adding to the cells. There would be required 2,098÷0.80=2,747 grams of bullion thus dissolved, making the total bullion treated per cell per day 8,146+2,747=10,893 grams, of which 8,146 grams, or 74.8 per cent. would be treated electrolytically in the cell, and the rest, 25.2 per cent., would be dissolved chemically, and yet when added to the electrolyte, its gold deposited electrically.

(3) Basing calculations on the solution of a kilogram of anode, requiring the passage of 1,592,115 coulombs (16.49 Faradays), the 800 grams of gold dissolved has a corresponding 800 grams deposited, so that no chemical energy needs to be expended for it. For the other elements we have the following equations and heat absorptions or evolutions:

$$\begin{aligned} &Au\ Cl,^{3}aq + 3Ag = Au + 3\ Ag\ Cl \\ &-27{,}200 \qquad\qquad +3(29{,}000) = +\ 59{,}800 \text{ calories.} \\ &2\ Au\ Cl,^{3}aq + 3Cu = 2Au + 3\ Cu\ Cl\ 2aq. \\ &-2(27{,}000) \qquad\qquad +3(62{,}500) = +133{,}500 \quad \text{“} \\ &4\ Au\ Cl,^{3}aq + 3\,Pt = 4Au + 3\ Pt\ Cl^{4}aq. \\ &-4(27{,}00) \qquad\qquad +3(79{,}800 = +131{,}400 \quad \text{“} \end{aligned}$$

The above heat evolutions are for the solution of, respectively,

3 gram atomic weights of silver =324 grams.
3 “ “ “ “ copper =190.8 “
3 “ “ “ “ platinum=585.0 ”

The heat evolution per kilogram of anode corroded will therefore be for:

$$\text{80 grains silver} = \frac{80}{324} \times 59{,}800 = 14{,}765 \text{ calories.}$$

$$\text{100 “ copper} = \frac{100}{190.8} \times 133{,}500 = 69{,}980 \quad \text{“}$$

$$\text{20 “ platinum} = \frac{20}{585} \times 131{,}400 = 450 \quad \text{“}$$

$$\text{Sum} = \overline{85{,}195} \quad \text{“}$$

This heat evolution takes place for the passage of 1,592,115

coulombs (16.46 Faradays). For one Faraday (96,540 coulombs) it will be,

$$85{,}195 \div 16.49 = 5{,}167 \text{ calories.}$$

and since one Faraday falling in potential one volt represents 23,040 calories, the heat *evolution* will *generate*

$$5{,}167 \div 23{,}040 = 0.224 \text{ volts}$$

which means that the fall of potential for chemical work is negative, *i. e.*,

$$V^d = -0.224 \text{ volts} \qquad (3)$$

It is interesting to note that, the observed total drop of potential across the baths being 0.7 volt, the voltage drop to overcome ohmic resistance must be *greater* than this, *i. e.*,

$$\begin{aligned} V &= V^d + V^c \\ 0.7 &= -0.224 + V^c \\ V^c &= 0.7 + 0.224 = 0.924 \text{ volt.} \end{aligned}$$

making the ohmic resistance of the cell

$$R = \frac{0.924}{150} = 0.00616 \text{ ohms}$$

$$= 6.16 \text{ milli-ohms}$$

Further, if no external source of current were used, the cell would have available 0.224 volt electromotive force, which should, if short circuited, send

$$\frac{0.224}{0.00616} = 36.3 \text{ amperes}$$

through the bath, that is, run it at 24 per cent. of the present rate, without any external generator of current.

RISE IN TEMPERATURE OF BATHS.

A subject of much importance is that of the temperature of an electrolytic cell being maintained above the room temperature by the heating effect of the current. It is difficult to calculate ahead, before the apparatus is constructed, how high its temperature will rise above its surroundings, but it may be determined with considerable approach to accuracy how high it

will be heated as soon as it has been constructed, and before electric current is applied, by a simple test.

The tank is filled with electrolyte, the electrodes put in place, and note made of the weight of electrodes and electrolyte. The tank is heated by a steam pipe until at desired temperature above the room, and then allowed to cool by radiation, with thermometer immersed in the electrolyte so as to determine the rate of fall of temperature per minute. An ordinary tank will cool approximately twice as fast if uncovered as if covered. Tests on a small tank showed, for example, the following results:

At	90°	C.	falling	3°.2	per minute.
"	80°	"	"	1°.7	" "
"	70°	"	"	1°.1	" "
"	60°	"	"	1°.0	" "

Knowing the weight and heat capacity of the electrodes and electrolyte (to which may be added half the heat value of the tank), it can be calculated how much heat is being lost per minute at any of the above temperatures. To maintain the bath at that temperature would therefore require just that much heat to be generated within it electrically in overcoming the ohmic resistance, and if we know or have calculated the electric resistance of the bath we have,

$$\text{Heat generated in bath} = (\text{current used})^2 \times \text{resistance} \times 0.2385 \text{ calories per second,}$$

and therefore the current required to supply any required quantity of gram-calories per minute will be,

$$\text{Current} = \sqrt{\frac{\text{Heat to be generated in bath per minute}}{\text{resistance of bath in ohms} \times 0.2385 \times 60}}$$

This same method of investigation can be applied to apparatus working with fused salts, or electric furnaces, providing that means of measuring the temperature satisfactorily are at hand.

ENERGY REQUIRED FOR CHEMICAL WORK.

This energy must be equal in amount to the chemical work done, and the only measure of this that we have are the thermochemical heats of combination of the separated-out products to

re-form the original material. A most striking generalization has been arrived at by the discussion of thermochemical data, viz., that taking the heats of formation of salts plus their heat of solution in excess of water (usually called "heat of formation to dilute solution"), these quantities are found to be *additive* in their nature, such being composed of the sum of two quantities, one characteristic once for all of the base, in all its combinations, and the other being characteristic once for all of the acid radical, in all of its combinations. There is thus for each basic element a *thermochemical constant*, which represents the amount of heat it contributes to the formation-heat of a salt, the latter taken in dilute solution; and for each acid radical a similar *thermochemical constant*, representing in a similar manner the part which it contributes; the sum of these two thermochemical constants is the formation heat of the salt, from its elements, to dilute solution. The thermochemical constant is nothing more nor less, in the case of a base, than *energy drop* which represents the decrease of free energy in the element as it passes from the free, uncombined state into the combined state in dilute solution; in the case of an acid element, the statement is entirely similar; in the case of an acid (or basic) radical, it is the total energy drop from free elements to the state of combination as a radical.

The arbitrary basis selected to which to refer these thermochemical constants is best that of hydrogen constant equal to zero. This would make the thermochemical constant of every basic element the heat evolved when it displaces hydrogen from a dilute solution of acid; and that of an acid element or radical the heat of formation of the corresponding acid in dilute solution. Practically, the thermochemical constants have been evaluated by the comparison of the heats of formation of many acids and salts, and the selection of the most probable experimental values. The following tables have been thus derived by the writer from an extensive discussion of the subject matter. The constants are given in every case *per one chemical equivalent* for the base or acid, element or radical, and *not* for the normal number of equivalents which are designated by the symbol and dots (·) or accents (′).

I have also given the voltage drop corresponding to an energy drop of the designated number of calories per chemical

equivalent, by the simple procedure of dividing the latter by 23,040.

THERMOCHEMICAL CONSTANTS OF BASIC ELEMENTS.

	Per Chemical Equivalent.		Corresponding Voltage.
$Li^{\cdot}$	+62,900	calories	+2.73
$Rb^{\cdot}$	62,000	"	2.69
$K^{\cdot}$	61,900	"	2.69
$Ba^{\cdot\cdot}$	59,950	"	2.60
$Sr^{\cdot\cdot}$	58,700	"	2.55
$Na^{\cdot}$	57,200	"	2.48
$Ca^{\cdot\cdot}$	54,400	"	2.36
$Mg^{\cdot\cdot}$	54,300	"	2.36
$Al^{\cdot\cdot\cdot}$	40,100	"	1.74
$(N+H_4)^{\cdot}$	33,400	"	1.45
$Mn^{\cdot\cdot}$	24,900	"	1.08
$Zn^{\cdot\cdot}$	17,200	"	0.75
$Fe^{\cdot\cdot}$	10,900	"	0.47
$Cd^{\cdot\cdot}$	9,000	"	0.39
$Co^{\cdot\cdot}$	8,200	"	0.36
$Ni^{\cdot\cdot}$	7,700	"	0.33
$Fe^{\cdot\cdot\cdot}$	3,230	"	0.14
$Sn^{\cdot\cdot}$	1,900	"	0.08
$Pb^{\cdot\cdot}$	400	"	0.02
$H^{\cdot}$	0	"	0
$Tl^{\cdot\cdot}$	— 900	"	—0.04
$Cu^{\cdot\cdot}$	— 7,900	"	—0.34
$Hg^{\cdot\cdot}$	—14,250	"	—0.62
$Pt^{\cdot\cdot\cdot\cdot}$	—19,450	"	—0.84
$Ag^{\cdot}$	—25,200	"	—1.10
$Au^{\cdot\cdot\cdot}$	—30,300	"	—1.32

THERMOCHEMICAL CONSTANTS OF ACID ELEMENTS.

	Per Chemical Equivalent.	Corresponding Voltage.	Salt.
F_2''(gas)	+52,900	+2.30	Fluoride
Cl_2'' "	39,400	1.71	Chloride
Br_2'' "	32,300	1.40	Bromide
Br′(liquid)	28,600	1.20	"
Br′(solid)	27,300	1.18	"
I_2''(gas)	20,000	0.87	Iodide
I′(liquid)	14,600	0.63	"
I′(solid)	13,200	0.57	"
S″ "	— 5,100	—0.22	Sulphide
Se″(met.)	—17,900	—0.78	Selenide

THERMOCHEMICAL CONSTANTS OF ACID RADICALS.

(From their elements.)

Constituents.	Radical.	Per Chemical Equivalent.	Corresponding Voltage.	Salts.
O_2(gas),H_2(gas)	(OH)′	+55,200	+2.40	Hydrate
S(solid),H_2 "	(SH)′	3,400	0.15	Sulphydrate
Se(met),H_2 "	(SeH)′	19,100	0.83	Selenhydrate
Cl_2(gas),O_2 "	(ClO)′	27,500	1.19	Hypochlorite
" " " "	$(ClO_3)'$	21,900	0.95	Chlorate
" " " "	$(ClO_4)'$	39,400	1.71	Per-chlorate
Br_2 " O_2 "	(BrO)′	28,600	1.24	Hypo-bromite
" " " "	$(BrO_3)'$	12,500	0.54	Bromate
I " O_2 "	$(IO_3)'$	65,000	2.82	Iodate
" " " "	$(IO_4)'$	52,600	2.28	Per-iodate
S(solid) O_2 "	$(S_2O_3)''$	71,750	3.11	Hypo-sulphite
" " " "	$(SO_3)''$	75,100	3.26	Sulphite
H_2(gas)" " " "	$(HSO_3)'$	149,400	6.48	Bi-sulphite
" " " "	$(S_2O_5)''$	115.200	5.00	Pyro-sulphite
" " " "	$(SO_4)''$	107,000	4.64	Sulphate
H_2(gas)" " " "	$(HSO_4)'$	211,100	9.16	Bi-sulphate
" " " "	$(S_2O_8)''$	158,100	6.86	Per-sulphate
" " " "	$(S_2O_6)''$	138,500	6.01	Di-thionate
" " " "	$(S_3O_6)''$	136,500	5.92	Tri-thionate
" " " "	$(S_4O_6)''$	130,600	5.67	Tetra-thionate
" " " "	$(S_5O_6)''$	133,100	5.78	Penta-thionate
Se(solid)O_2 "	$(SeO_3)''$	60,050	2.61	Selenite

" " " "	$(SeO_4)''$	72,800	3.16	Selenate
$P(solid)O_2$ "	$(PO_4)'''$	99,300	4.31	Phosphate
$H_2(gas)$ " " "	$(HPO_4)''$	152,750	6.63	Mono-H-Phosphate
" " " " "	$(H_2PO_4)'$	307,700	13.35	Di-H-Phosphate
$As(solid)O_2$ "	$(AsO_2)''$	102,150	4.43	Arsenite
" " " "	$(AsO_4)'''$	70,200	3.05	Arsenate
$H_2(gas)$ " "	$(HAsO_4)''$	71,700	3.11	Mono-H-Arsenate
" " " " "	$(H_2AsO_4)'$	217,200	9.43	Di-H-Arsenate
$N_2(gas)$ O_2 "	$(NO_3)'$	48,800	2.12	Nitrate
" " " "	$(NO_2)'$	27,000	1.17	Nitrite
" " " "	$(NO)'$	—3,800	—0.16	Hypo-nitrite
$C(amor.)O_2$ "	$(C_2O_4)''$	99,800	4.33	Oxalate
" " " "	$(CO_3)''$	82,450	3.58	Carbonate
$H_2(gas)$ " " "	$(HCO_3)'$	169,100	7.34	Bi-Carbonate
" " " " "	$(CHO_2)''$	104,600	4.54	Formate
" " " " "	$(C_2H_3O_2)''$	120,500	5.23	Acetate
$N_2(gas)$ " " "	$(CNO)'$	37,100	1.61	Cyanate
" " N_2 "	$(CN)'$	—34,900	—1.51	Cyanide
S(solid) " " "	$(CNS)'$	—18,100	—0.79	Sulpho-cyanide
Fe(solid)" " "	$(FeC_6N_6)''''$	—25,600	—1.11	Ferro-cyanide
" " " " "	$(FeC_6N_6)'''$	—52,800	—2.29	Ferrie-cyanide

In using above tables, it must be borne in mind that the sum of the thermochemical constants for the basic and acid constituents of any salt, gives the heat of formation of the salt from the constituent chemical *elements*, in dilute solution. Conversely, the heat of formation thus obtained, is the energy necessary to separate the salt in dilute solution into its constituent chemical elements. The sum of the voltages, corresponding to this amount of chemical energy, is the voltage necessary to decompose the salt in solution into its constituent, free chemical elements. If these elements re-combine in the process of decomposition, to form other chemical compounds, then the whole chemical reaction must be taken into account,—best on the total energy basis; and when this is expressed in calories per chemical equivalent concerned, the necessary voltage for producing the change is obtained by dividing this by 23,040.

Lehigh University, December, 1905.

ALUMINUM FOR PATTERNS.

Aluminum is now being used to some extent as a pattern metal, the former difficulties connected with soldering it having been solved. The most satisfactory alloy for soldering consists of 1 part of aluminum, 1 of phosphor tin, 11 of zinc and 29 of tin. To avoid loss of the more easily volatile of these metals the aluminum is melted first, then zinc is added in small pieces, then tin in small pieces and lastly the phosphor-tin. For the soldering no acid is used, but the surfaces to be joined are first covered with a thin coat of the solder in the usual way and then brought together and heated with the soldering copper or a blow pipe or torch until the solder already upon them is melted, when pressure is applied and the joint is made. Aluminum must be heated to about 660 degrees F. before it can be soldered.—*Iron Age.*

UNUSUALLY HEAVY RAILS.

The rails on the belt line railroad around Philadelphia are the heaviest used anywhere in the world, weighing 142 pounds per yard, or 17 pounds more than any previously fitted. They are ballasted in concrete, with 9-inch girders to bind them. All the curves and spurs have the same heavy rails, which were made especially for the Pennsylvania Railroad by the Pennsylvania Steel Company. An officer of the railroad states that this section of road ought to last for 25 years without requiring repairs. The section is considered superior to any other in existence.

INCREASING SPEED OF WARSHIPS.

The average speed of warships is rapidly increasing. Excluding torpedo craft, the warships built and building for the several powers July 1, 1899, had a mean speed of 16.92 knots. This speed has become successively 17.24 in 1900, 17.49 in 1901, 17.89 in 1902, 18.17 in 1903, 18.39 in 1904 and 18.71 in 1905. This increase of nearly two knots is due largely to the construction of large numbers of large armored cruisers, most of which are capable of steaming 22 knots or over, while the building of smaller and slow ships has heavily decreased. The mean speed of the warships of the eight greatest naval powers in 1905 are: England, 19.82; Japan, 19.41; Italy, 18.79; Austria, 18.65; Unied States, 18.64; France, 18.56; Germany, 18.18, and Russia, 17.29 knots. The fastest navy is that possessed by Chili which with only eleven ships, largely very swift cruisers, has a mean speed of 20.71 knots.

A NEWLY INVENTED GERMAN TYPEWRITER,

Not yet upon the market, prints syllables and short words instead of only single letters. It is said to be remarkably rapid. With a language as complex as English it seems doubtful if such a device could be made practicable, unless it were to have a wholly prohibitive number of characters.

Mechanical and Engineering Section.

(Stated Meeting, held Thursday, November 16, 1905.)

The Selection of Material for the Construction of Hydraulic Machinery.

By Arthur Falkenau.

Member of the Institute.

In the designing of hydraulic machinery one of the most important considerations is the determination of the material to be used. The determining factors are, first: the function of the machine or appliance; second: The space available for placing the apparatus; third: The hydraulic pressure involved; fourth: The velocity of the flow of water or other liquid; fifth: In the case of pumping machinery, the kind of fluid to be pumped. Possibly I should have mentioned the last consideration first, but in speaking of hydraulic machinery I had in mind mainly hydraulic presses working under the higher pressures. As to the functions of hydraulic machines or appliances they can be divided into four great classes: 1st, Presses and Intensifiers; 2nd, Pipes; 3rd, Valves; and 4th, Pumps.

Of course the first consideration in designing a press is the total pressure to be exerted, and the second is what hydraulic pressure is to be used or is available. This is at times governed by the space available for the machine, and I have known of instances where in order not to have too cumbersome a machine, and the space being limited, it became necessary to use a factor of safety of three or four referring to the ultimate strength of the materials of construction. Of course, in every construction the expense is to be considered, and this frequently determines the choice of cast iron or steel castings for hydraulic cylinders. At times extreme high pressures indicate the desirability of using steel forgings for cylinders. If the cylinder is to receive a plunger which can be packed externally, cast iron

or steel castings prove very satisfactory, but where a piston is to operate in the cylinder, on account of the wear of the leather packing a forged cylinder, bored and ground, gives the best results. With castings a copper lining is frequently resorted to in order to present a smooth surface to the leather.

A most important consideration is the density of the material entirely aside from the tensile strength. Water under 3000 or 4000 pounds pressure will ooze through cylinder walls made of ordinary gray iron 3″ to 4″ thick, that is, if it is open-grained iron. For these high pressures it is usual to use air-furnace iron, which, besides giving a tensile strength of 30,000 to 32,000 pounds, furnishes a very dense material, and now that steel castings are so much more reliable than formerly, steel castings are supplanting the air-furnace iron.

In this connection I would say that in my experience, however, I have known air-furnace iron to fail where a good ordinary casting was successful. This was largely due to the manner of the casting and local shrinkages from gates and risers. The failure of cylinders or valve body castings to be thoroughly impervious to the water is frequently the cause of great annoyance and expense in the construction of hydraulic machinery. I have had cases where on account of the anxiety of the customer to obtain the machine we have had to pass cylinder or valve bodies which when first tested failed to hold the pressure, the water oozing through the walls quite rapidly. We remedied the defect by pumping starchy fluid prepared from potatoes into the cylinders, and after half an hour to an hours work, the cylinders were bottle tight. These cylinders were put to work under water pressure of 1500 pounds, and they have remained permanently tight. I designedly use the word "water-tight," as a later experience proved to me that the starch caulking method is not oil tight. In building some 200 ton pressure with 10inch cylinders we used cupola iron castings. As they proved defective we next ordered some of the air-furnace iron. After trying three of these, all of which proved defective, in order to meet the importunities of our customers, we concluded to try the starct caulking method. Within a half hour the cylinders were perfectly tight, and after having a hydraulic pressure of 400 pounds per square inch applied to them, and locking this pressure in the cylinder, a drop of only

ten pounds was recorded after twelve hours. We thought that our annoying problem was solved, and expedited the machine to the customer's work. The next morning we were informed that the cylinder was leaking badly, and on inspection found that our customer was using oil, and that the oil oozed through the cylinder at an apparently greater rate than the water had done originally. I suppose that the oil must have had some dissolving effect upon the starch. As we had had such unsatisfactory results with the air-furnace iron I concluded that the only rapid solution of our trouble would be some other way of sealing up the pores of the cylinder. As the leak indicated, the porisity was mostly at the bottom of the cylinder. We therefore had the inside of the cylinder towards the bottom brazed by the ferrofix process. This proved entirely successful and the cylinder has remained sound ever since. I understand that in the case of steel cylinders the sealing by means of the thermit process has been successfully used.

It may be interesting to note here that in the year 1849 the first cylinders used in the hydraulic presses constructed for raising the tubes of the Brittania bridge into position proved porous and leaky, and were made tight by pumping oat meal gruel and sal ammoniac into them. These cast-iron cylinders were 20 inches in diameter and had walls 8¾ inches thick. When they failed, they were replaced by cylinders made of wrought-iron with 8 inch walls. When the wrought-iron cylinders were first put to work, the engineers were discouraged due to the fact that the cylinders expanded under the great pressure causing the pistons to leak. New pistons were made but the expansion continued. The outer diameter, however, remained constant, and this encouraged the engineers to persist in making new pistons until the inner portion of the cylinders had taken a permanent set.

In valves and pumps where water under high pressure attains a high velocity it has been a general experience that cast-iron and steel are frequently subjected to a peculiar cutting action. According to my own observation this cutting action has been decidedly more rapid and marked when two dissimilar metals were in contact; thus in the Loss valves which we built we originally used steel valves and bronze bodies. In several instances after a year or two we found the steel valve ap-

parently eaten out as if by an acid. In one particular instance, believing that acid or grit in the water was the cause of the trouble, a water filter was put in place and only pure filtered water was used throughout the system. The new steel valves were soon eaten as badly as the former ones. It may be that some tannic acid washing out of the leather packing had something to do with this action, or the action may be of an electric nature. We replaced the steel valves by bronze ones so that two like metals were in contact and no further trouble was experienced. I have examined samples showing this peculiar pitting action which, as the location showed could not have been caused by the impact of the water, due to high velocity in passing out of the valve. Still the fact that this action occurs near the point of efflux, and not so much elsewhere, might lead one to discontinuance the electric couple theory. This peculiar action, I believe, has been observed by a great many engineers, but does not seem to have been satisfactorily explained. For small structures under high hydraulic pressures, say from 3000 to 8000 pounds, forgings are far more satisfactory than castings, and I have found bronze under these high pressures unsatisfactory solely owing to the low or uncertain elastic limit of the same. The castings seem to gradually expand and get leaky, although figured with the factor of safety of 6 to 10 based on the ultimate strength.

The material to be used for packing is also an important consideration. Where *U* or Cup leathers are used a close-grained flexible leather is desirable; of course, such leathers should not be taken except from the middle of the back of the animal. Leather treated with paraffin has given good results. There is no doubt that the method of preparation of the leather is an important factor in its imperviousness to water, and I have within recent years tried the Vim leather, which has given better results than any I had heretofore used. The manufacturers of the Vim leather claim that their peculiar process of tanning preserves the fibre and brings the fibres into closer contact. The process of tannage is one of oxidation by the use of a mineral, and for this reason the leather is not affected by oxide of iron as are oak- and hemlock-tanned leather. For light pressures the leather is furnished without any filler, but for high pressure the leather is filled with a lubricant which primarily hardens the

leather and renders it more impervious. It is claimed that owing to the process of tanning the Vim leather will absorb 45 per cent. of lubricant as compared with 15 per cent. absorbed by oak-taned leather. Furthermore, in moulding the leather no water is used, the leather being heated and thus sufficiently softened. The leather is not affected by hot water.

The blame for the failure of leathers, however, is frequently not chargeable to the material, but to the construction of the metal against which the leather rests. The *U* leather should, as far as posisble, be backed by the metal over its curved portion, and should have either a metallic ring or hemp or other material inserted between the flaps. Furthermore, the surface over which the leather runs should be as smooth as possible. some constructors in building cylinders in which pistons travel, line them with brass, aiming at the double purpose of furnishing a smooth surface and covering any porous structure which may appear in the cast-iorn or cast-steel cylinders.

Where leathers are used in valves in such a way that they cross ports the construction should be such as to avoid blowing the leather out into the ports. I desire, however, to confine myself to the question of the kind and quality of the material to be used, and only call attention to these points of construction which, if neglected, may cause damage which should not be charged to the material.

In choosing the material for pumps used in removing fluids, such as mine pumps, ammonia pumps, etc., the question of chemical action on material is of great importance. In many of the mines in the anthracite coal regions the water is so permeated by sulphuric acid that cast-iron cannot be used with any satisfaction. For several years I had preserved a specimen, which I had broken from a pump that had been in use some four years. The metal had been three-fourths of an inch thick. This was no longer cast-iron, as the iron had been removed and only the graphite remained, and I could write with it as with a pencil.

This subject, "The selection of a suitable material for the construction of hydraulic machinery," of course, is a very large one, and can not be adequately treated in a short paper. My object was simply to present a few notes that might bring out interesting discussion.

THE COURSE OF THE MINING INDUSTRIES DURING 1905.

Dr. David T. Day, of the United States Geological Survey, who brings out each year a volume entitled "Mineral Resources of the United States," is authority for the statement that the general prosperity of the year 1905, due to good crops, excellent foreign trade, and business confidence, was emphatically expressed in the greatest production of minerals ever known in the history of our country. Good crops stimulated the railroads to increase their rolling stock. The direct consequence of that increase was a heavy demand on the iron and steel trades, which in turn extended the expansion movement to coal and coke.

The preliminary estimate made by the Director of the Mint of the production of gold and silver in the United States during the calendar year 1905 shows a gain approximately $6,000,000 in gold and 1,000,000 ounces of silver over the output of 1904. The gain in gold is represented almost entirely by the increased output of Alaska, which is placed at $14,650,100 as against $9,160,500 in 1904. The Alaskan gain is nearly all in the Tanana or Fairbanks district, the returns for which are $5,107,000. California shows a loss in gold product of about $1,500,000, due to prolonged draught, which not only brought hydraulic operations to a standstill but interfered, to some extent, with quartz mills. Nevada shows a gain of about $400,000, and Utah an equal increase. Colorado's gains amounted to about $1,000,000.

The ill wind of war and revolution which brought disaster to the Russian petroleum industry carried prosperity to the productive oil areas of the United States. To supply the increased demand from abroad, which resulted from Russia's deficit, strained the petroleum resources of this country to their utmost.

The demand for copper during 1905 was intense and prices were high. This demand for copper affected other metals sympathetically, especially aluminum, which floats on the copper market as a substitute for copper conductors, and is more or less sought, according to the price of copper.

General prosperity was sufficiently pronounced to make itself felt in the building trades, is shown by the increased production of structural steel, brick, terra-cotta, and stone. Of all the structural materials, cement profited most by the forward movement, which came, fortunately, at a time when a favorable market was necessary to take care of existing stocks.

Prosperous conditions were reflected even in the sale of precious stones, although a large majority of the business consisted of sales of diamonds from abroad, which brought unusually high prices.

IMPROVEMENT IN MAKING ARMOR PLATE.

Charles C. Davis, of Germantown, Philadelphia, has patented a process of cementing, or carbonizing, armor plate. Carbonaceous material is packed between two armor plates and a direct electric current is passed through the carbonaceous material and the plates, facilitating the absorption of carbon. The plates are maintained at a temperature of from 800 to 850 degrees C.

(Stated Meeting, held Thursday, November 16, 1905.)

Some Data Relating to the Heating of the Edgar F. Smith House, Dormitories, University Pennsylvania.

By H. W. Spangler.

The University Dormitories are a group of twenty-one buildings under a common roof, divided into separate houses, each with its own entrance from an interior quadrangle. These buildings would extend about 1325 feet if in one row, and when the entire system is completed they will have a combined length of 2475 feet. At present they will house about 589 students, there being seventy-nine three-room suites, consisting of a study and two bed-chambers, two four-room suites, sixty-three double rooms and 291 single rooms. These buildings are of brick with stone trimmings, terra-cotta floors and ceilings and have a slate roof on wooden rafters. The rooms are used for living rooms only, and toilets and baths are provided on each of the upper floors. These buildings are all heated and lighted from the Central Station, about 1200 feet away. High-pressure steam is carried underground for heating, the main steam supply extending about 2000 feet from the boiler house to the extreme building. The cost of heat furnished to the occupants is included in the rental, and the Dormitories pay the Light and Heat Station their pro rata of the cost of operation. In that portion of the Dormitories originally built, the charge for light

is included in the rental, but in all later houses the occupants pay by meter.

That portion of the Dormitories originally built, housing 361 students, is heated indirectly, stack of indirect radiators being located in the basement. An independent mixing damper, controlled from each room, is intended to be used for regulating the heat received, the entire basement acting as a cold air chamber. As several rooms are heated from one stack of in-

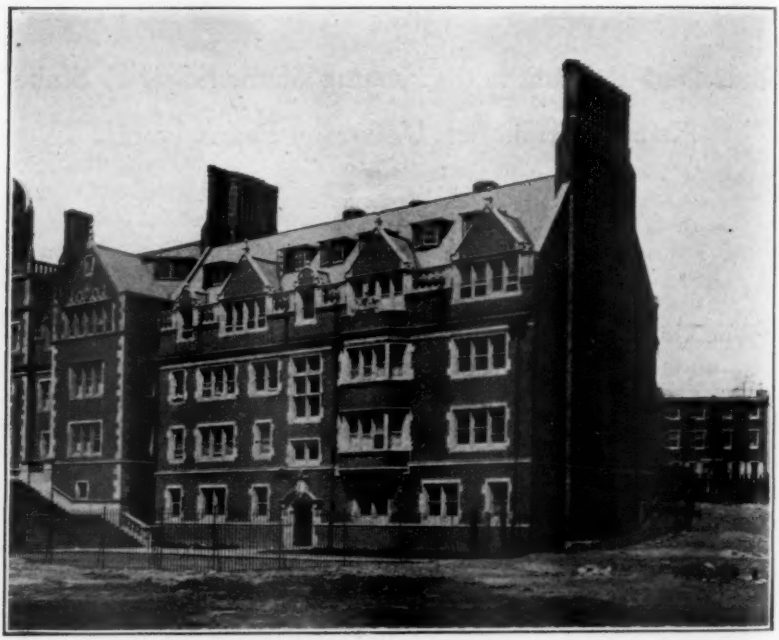


Fig. 1—University Dormitories—Edgar F. Smith House. Southern Exposure.

directs, the control of the heat is not entirely satisfactory; first, because hand-dampers in the heat pipes must be regulated from time to time during the winter, and secondly, it is possible, as for instance when the wind is blowing on the north side of the house, that an open window on one floor will permit cold air to pass down into the top of the heat stack in the basement and thence up into a room on another floor, supplied from the same stack, and thus entirely cut off the heat supply.

In building the second lot of houses, consisting of 146 apartments, it was decided to use direct radiators for heating, with an auxiliary fan system for very cold weather. The real service obtained from an auxiliary system was so small, that, after a few of the direct radiators had been increased in size, the fan system was no longer necessary.

The last house built is shown in Figs. 1 and 2, Fig. 1 being the southern exposure, the blank wall on the eastern end being

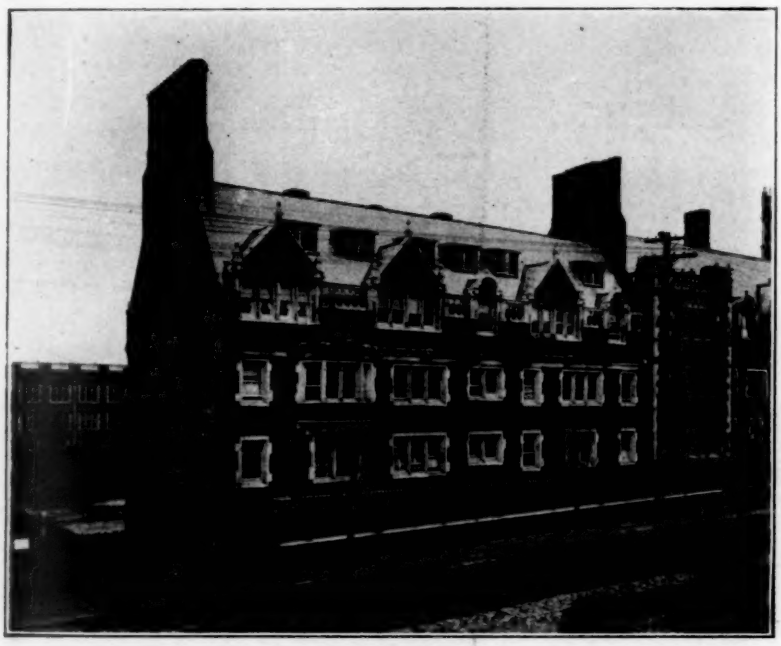


Fig. 2—Northern Exposure.

the separation between this house and the next one, now being erected. In building this house, called the Edgar F. Smith house, which contains thirty-two apartments, it was determined to heat all the rooms by direct radiation, the steam main being carried in the attic and a two-pipe system being employed. Figs. 3 and 4 show the working drawings from which the heating system of this building was laid out. The floor plans show the distribution of the radiating surface together with the general

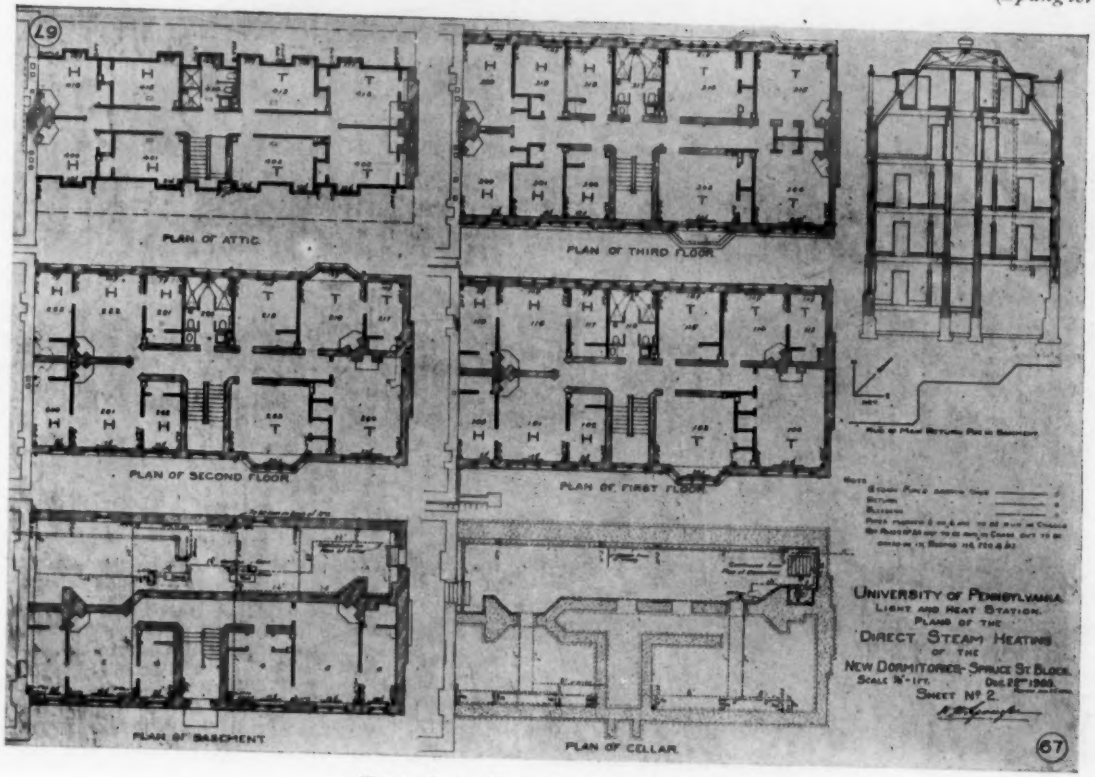


Fig. 3—Floor Plans—Radiator Distribution.

location of the risers and returns. Most of the piping is concealed in chases, the pipes being covered with one inch of cork sectional covering before being closed in.

The amount of radiation required was calculated carefully from the exposed surface. A form is used for making the calculation, one being used for each room. The one reproduced in Fig. 5 is for room 219 in this house. In the lower left-hand corner will be seen a sketch of the room, with dimensions. The desired temperatures are as shown, zero on the north side, 70 in the room, 70 above and 70 below the room, 60 on the south side, 70 on the east and 70 on the west.

The table shows, in the first column, the location of the wall, in the second and third the kind of wall and the next column the area. $\triangle \mathbf{T}$ is the temperature difference on the two sides of this wall, **C** is the constant for the heat transmitted per square foot of surface per degree difference of temperature. **Ex.C.** is a constant depending on the exposure of the building, nearness of surrounding buildings, etc. The last column shows the expected heat loss from the room. On a basis of 300 B.T.U. per hour, the number of feet of radiating surface is determined.

The constants used are practically those developed by Kinealy with some modifications and have been tested by us in other of our buildings and found to satisfactorily determine the amount of radiator surface required to heat our rooms under varying conditions. They are as follows:

Glass, S.		1.09	Ceiling, F. P.	12 in.	.10
Brick	9 in.	.35		9 in.	.15
	14 in.	.28	Door, outside	2 in.	.42
	18 in.	.24	inside	1 in.	.40
Brick and Stone	42 in.	.24	Lath and Plaster		.34

The following table shows the actual volume and the square feet of radiator surface provided in the various rooms. The radiators marked "T" are controlled by Thermograde valves and those marked "H" by ordinary hand valves on the supply, the return being controlled by an automatic check. It may be of interest to state that no trouble is experienced with these check-valves if put in as shown in Fig. 4, that is, if the check is dropped to about four inches below the outlet on the radiator.

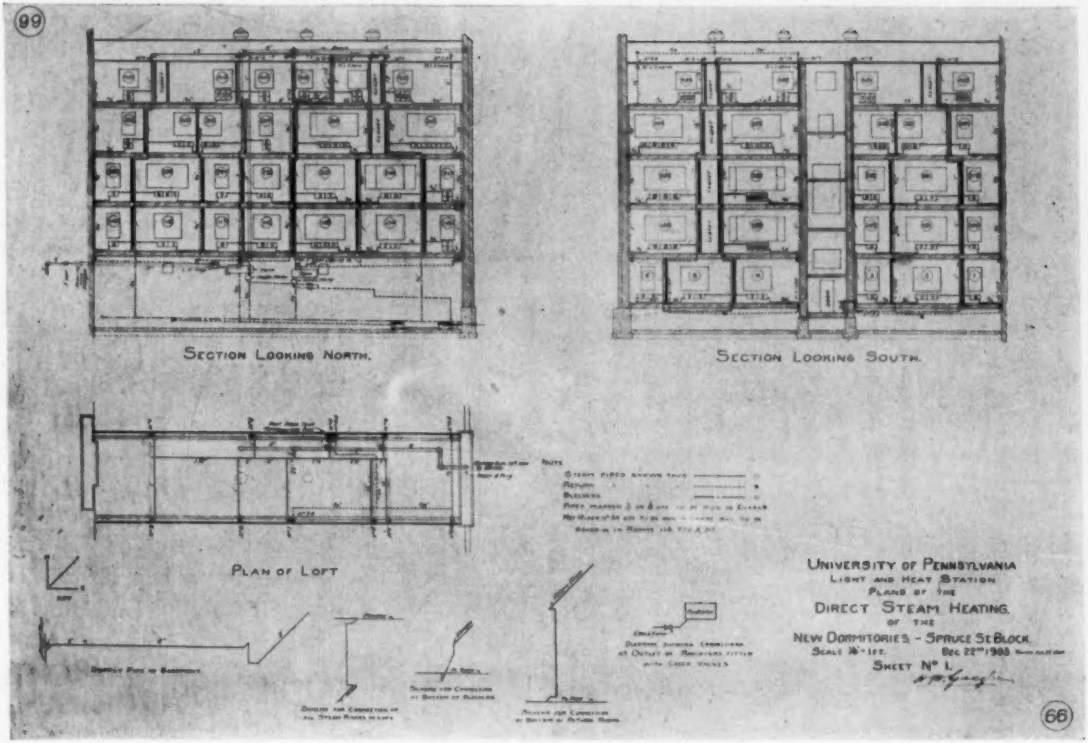


Fig. 4—Riser Diagram.

VOLUME AND RADIATOR SURFACE.

Room	Vol. cu. ft.	Rad. surface sq. ft.	Ratio	Room	Vol. cu. ft.	Rad. surface sq. ft.	Ratio
1	1080	9	120	219	1575	14 T.	113
2	2160	14	154	220	1215	10	122
3	900	9	100	221	945	7 H.	135
4	1575	14	113	222	2160	16 H.	135
5	2385	14	70	223	1125	7 H.	161
6	1260	18	70	Hall	2790		
1st Hall	1390			300	1620	9 H.	180
Vesti'le	1035	21		301	1260	12 H.	105
100	1125	6 H.	188	302	1125	12 H.	94
101	2160	14 H.	154	303	2385	21 T.	114
102	945	9 H.	105	304	2115	24 T.	88
103	2340	24 T.	97	315	2070	28 T.	74
104	2700	27 T.	100	316	2250	21 T.	107
113	945	14 T.	68	317	1215	10	122
114	1665	14 T.	119	318	1125	12 H.	94
115	1575	18 T.	88	319	1215	14 H.	87
116	1215	12	101	320	1620	12 H.	135
117	945	9 H.	105	Hall	3465		
118	2160	14 H.	154	400	1230	15 H.	82
119	1125	9 H.	125	401	1200	21 H.	57
Hall	2790			402	1310	24 T.	55
200	1125	6 H.	188	403	1555	27 T.	57
201	2160	14 H.	154	412	1555	27 T.	57
202	945	10 H.	95	413	1300	28 T.	46
203	2340	24 T.	97	414	800	18	44
204	2700	27 T.	100	415	1155	21 H.	55
217	945	14 T.	68	416	1250	18 H.	69
218	1800	18 T.	100	Hall	2665		
				Entire Bld'g	90790	810	112

No radiators were put in the halls, except in the vestibule on the first floor. The number of cubic feet of space per square foot of radiator surface is large, and the large variation of this ratio is very notable, reaching a maximum of 188 cubic feet of space per square foot of radiator surface in well-protected rooms with small glass area, and a maximum of 44 cubic feet in exposed portions of the building.

In designing the plant it was the desire to obtain a temperature of 70° in the living rooms, 60° in the halls, and it was expected that a temperature of 50° would be obtained in the attic and cellar.

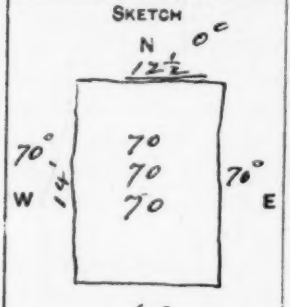
After the heating had been planned a proposal was made to us to use thermograde valves, and as the building was one in which such an installation could well be tested, an agreement was made to install such valves in part of the building, on a guaran-

No. 29

BDG. Dorm. ROOM 219 LOCATION House 21 CEILING 9 FT.

WALL	KIND	THICK	AREA	ΔT	C	EX. C	HEAT LOSS
N	Brick	18"	95	+70	.24	1.32	1900
	Glass	S.	20	+70	1.09	1.2	1800
E	Wood Stud	5"	125	0			
S	Brick	14"	115	+10	.28		300
W	Wood Stud		125	0			
CEIL.	F. P.	12"	175	0			
FLOOR	F. P.	12"	175	0			

SKETCH



VOLUME 1575 CU. FT.

TOTAL 4000

VENTILATION

OCCUPANTS No. ..... HT. .....

AIR SUPPLY ..... CU. FT.

T. CHANGE ..... HT. .....

FLUES .....

HEATING SURFACE

KIND	MAKE	SQ. FT.	ST.	D
1	7 + W. Wall	14	3/4	3/4

Fig. 5

tee to remove them at the end of the first winter if they were not in every way satisfactory to the writer.

As a result of this agreement, all the radiators in the rooms marked "T" on the heating drawings were supplied with thermograde valves and the returns were connected together and led through a meter for measurement.

All the radiators in the rooms marked "H" were connected to a second meter.

The following table gives some of the data relating to these rooms:

	On hand control.	On Thermograde control.
Number of rooms	22	18
Cubic contents	29,720 cu. ft.	33,125 cu. ft.
Square feet glass	340 sq. ft.	455 sq. ft.
Outside wall	1,935 sq. ft.	2,915 sq. ft.
Equivalent glass area (about)	824 sq. ft.	1,183 sq. ft.
Radiating surface including runouts	282 sq. ft.	406 sq. ft.
Outside equivalent glass per cu. ft. under the two systems is as	1 is to	1.26
Radiator surface per cu. ft. of space is as	1 is to	1.29
Pounds steam required to heat 1 cu. ft. of space is as	1 is to	.556

As it is necessary that the entire return from the thermograde system should be at atmospheric pressure the return risers were connected at the top in the attic and vented there, and at the bottom they discharged into a tank which also was vented. The supply risers are all connected at the bottom by a bleeder system, which takes care of the condensation in the risers. The returns from all the rooms marked "H" discharge through a trap and then into a tank and meter. The remaining rooms in the building are on an independent hand-control system.

The discharge from each of the two systems was taken to a tank and from this tank discharged through a tilting meter into the general return pipe leading back to the Central Station. Fig. 6 is a view of the basement showing the two tanks near the ceiling, the nearer one being that of the hand-controlled system, the trap on this system showing clearly above this tank. The meters are on the opposite wall.

The pressure on the heating system is regulated, in the adjacent house, by a plug reducing valve, of which a large num-

ber are in use on the general system. These valves require careful attention during the first season and but little thereafter. Figs. 7 and 8 are charts taken from the heating system of this building on the dates shown. Fig. 7 was taken when the valve was working entirely satisfactorily, having been cleaned two weeks before and practically having received no attention until the date at which this chart was taken. The chart, Fig. 8, shows the variation in pressure when the reducing valve was not working smoothly. The diagram hereafter reproduced shows when this valve was overhauled during the season.

Fig. 6—Basement—Showing Position of Return Tanks.

To determine the accuracy of the meters, tests were made of them by discharging the return water after it had passed through the meter into a tank on scales, in which the discharge was weighed, Fig. 9 showing the connections for testing. The temperature of the discharge water was also taken.

Test of meter 510—Hand.			Test of meter 511—Thermograde		
Dial reading Gals.	Wt. in tank Lbs.	Temp °F	Dial reading Gals.	Wt. in tank Lbs.	Temp. °F
0.0	209.0	146	1⅛	216.5	
1.0	216.0	146	6¼	255.0	
2.0	223.5	146	10⅛	285.5	
3.0	231.5	146	11⅛	293.25	
4.0	239.0	147	16¼	232.0	
5.0	246.3	147	20⅛	362.5	
6.0	254.0	146	25⅛	400.5	
7.0	261.5	146	26¼	408.0	
8.0	269.0	147	30⅛	438.5	
9.0	275.3	146	31⅛	446.25	
10.0	283.8	145	35⅛	476.5	
16.0	331.5	164	36¼	484.5	
20.0	361.3	148			
27.0	416.3	163			
30.0	438.0	163			
35.0	476.8	149			
40.0	514.8	151			
40.0	305.8	150	35⅛	268.	89°F.

Apparent Wt. per gallon, 7.65 lbs. Apparent Wt. per gallon, 7.63 lbs.

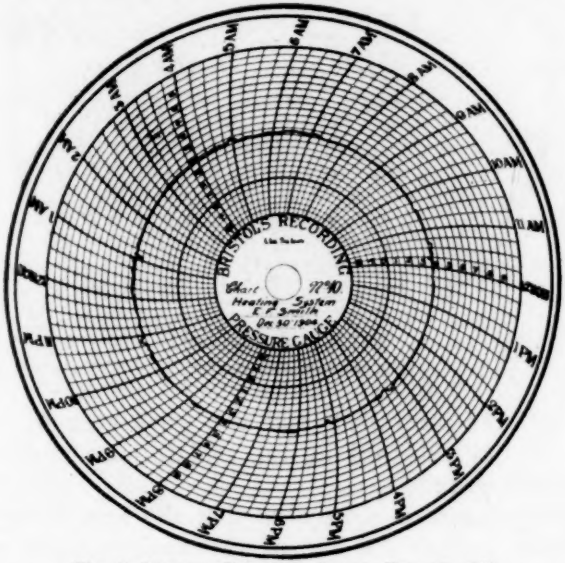


Fig. 7—Pressure Recording Gauge, Dec. 30, 1904.

The temperature of the return water averaged 89°F. for the thermograde system and 150°F. for that under hand control. The operation of the thermograde system is an intermittent one allowing part of the radiators to act as a hot water radia-

tor until the discharge valve opens, discharging the partly cooled water.

During the entire winter the readings of these meters were taken at noon each day and the quantity of return water was plotted on the chart, Fig. 10, showing the values obtained. At the beginning of the chart will be seen the scale to which it has been drawn, one of the larger divisions vertically representing .1 gallon of return water per square foot of radiating surface per twenty-four hours. Using the second column of figures one can read the total gallons returned per day by the radiators

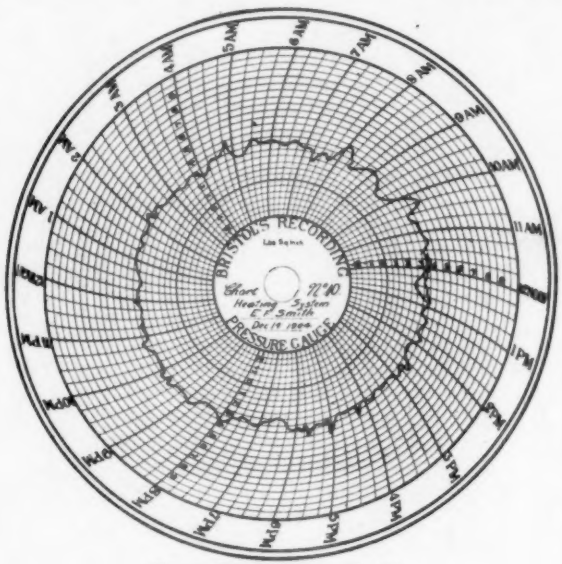


Fig. 8—Pressure Dec. 10, '04.

that were hand-controlled, and the third column gives the gallons per day returned by the radiators controlled by the thermograde system.

The temperature is plotted so that the line of variation in temperature follows the line of variation in water returned. That is, the zero of termepature is at the top of the diagram and of water returned is at the bottom. Four irregular lines are plotted on the diagram. The upper one shows the variation in temperature at 8 A.M. each day. Next below this, and crossing it generally on stormy days is the mean temperature

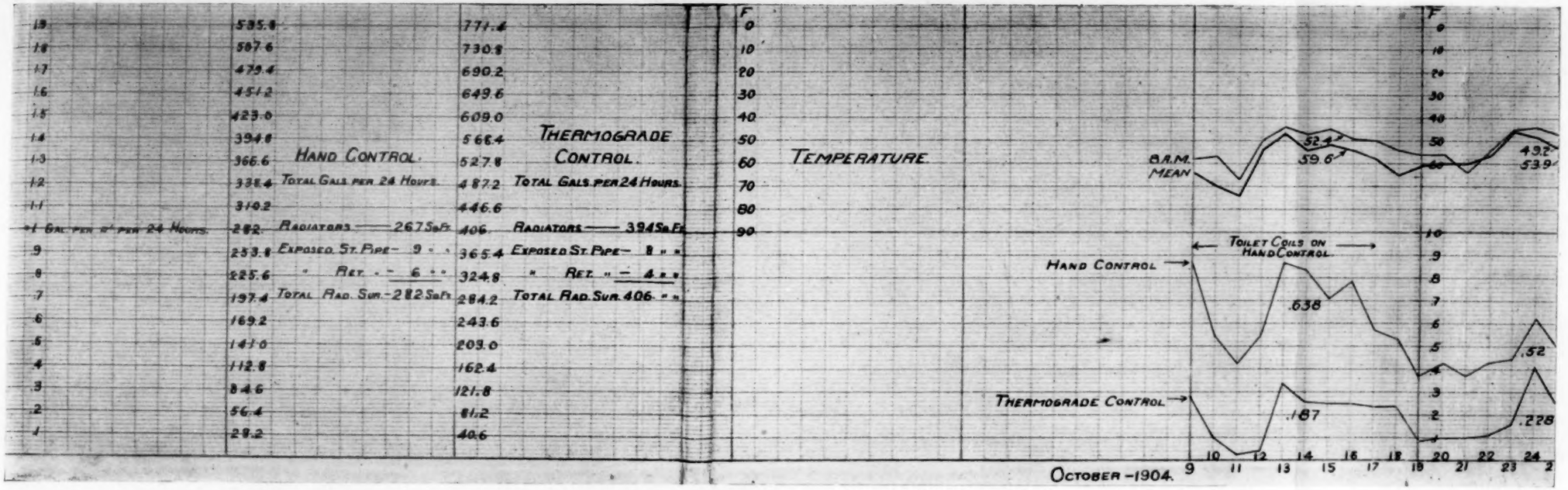


Fig. 10 A.

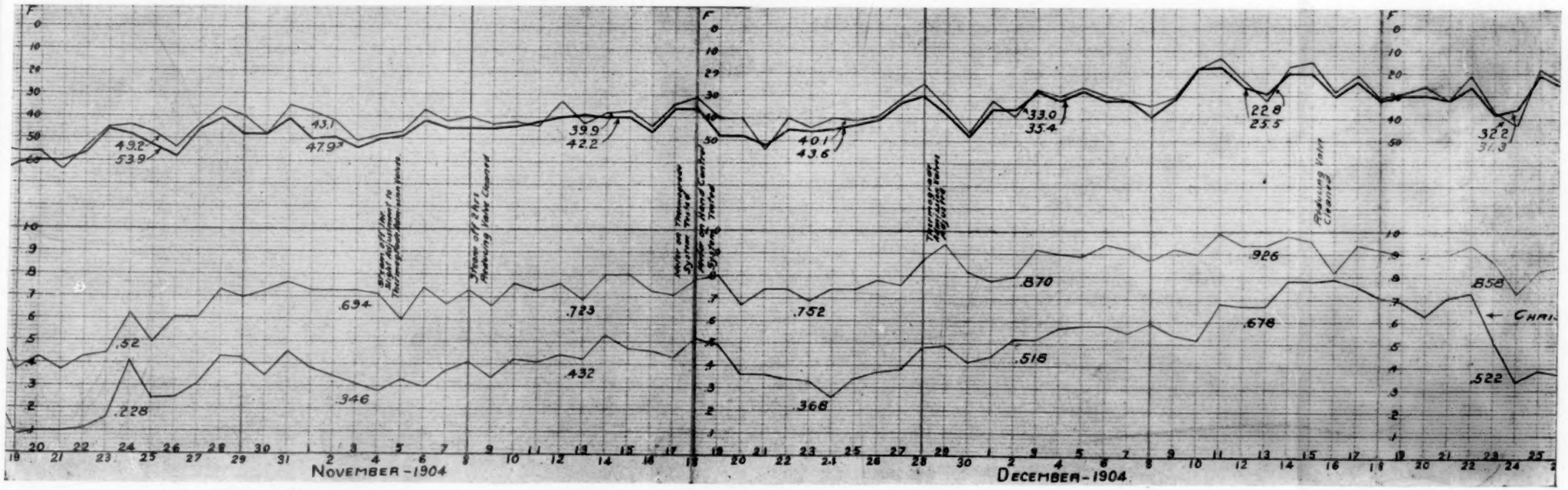


Fig. 10 B.

F
0
10
20
30
40
50
10
9
8
7
6
5
4
3
2
1
18

14

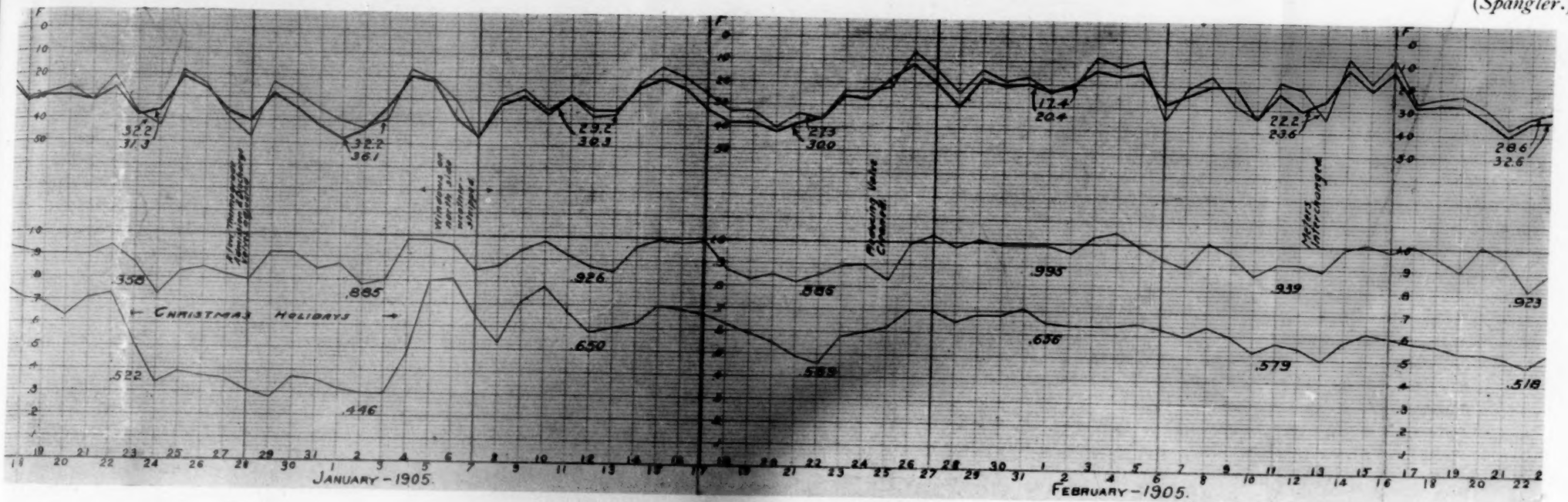


Fig. 10 C.

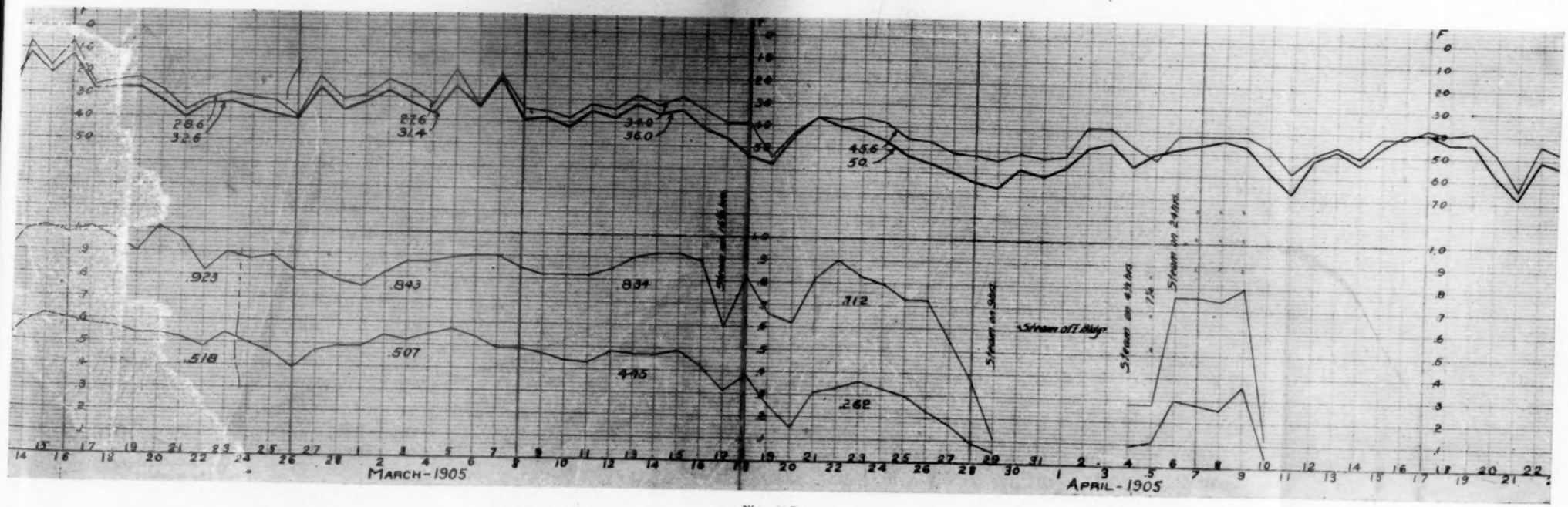


Fig. 10 D.

for each twenty-four hours. The next line shows the amount of steam condensed per square foot of radiating surface per day by those radiators which are under hand control. The lowest line shows the amount of steam condensed by the radiators under thermograde control. It will be noticed that all these lines follow the same general course, rising and falling in nearly the same way. The decided difference between the lower two curves for December 22nd to January 4th (Christmas Holidays) is interesting.

Fig. 9—Testing Meters.

It will be noticed that the reducing valve was cleaned on November 9th, December 15th and on January 24th. At the end of the first week in January all the windows facing the north were weather-stripped in the belief that the quantity of condensed steam returned from the hand control side would be greatly reduced.

From this diagramatic record the following table has been made showing the average value of the various quantities for each ten days, from the time steam was turned on in the Fall un-

til it was turned off at the end of March, during the first warm weather. The values in this table are shown also on Fig. 10.

1904	Mean Temp.	8 A. M. Temp.	Gallons of steam Cond. per sq. ft. per 24 hours: Hand control	Thermograde	
Oct. 9 to 19.....	59.6° F.	52.4° F.	.638	.187	Toil's on hand con-
Oct. 19 to 29.....	53.9	49.2	.520	.228	Toilets off. [trol.
Oct. 29 to Nov. 8.	47.4	43.1	.694	.346	
Nov. 8 to 18.....	42.2	39.9	.723	.432	
Nov. 18 to 28.....	43.6	40.1	.752	.368	
Nov. 28 to Dec. 8.	35.4	33.0	.870	.518	
Dec. 8 to 18.....	25.5	22.8	.926	.678	
Dec. 18 to 28.....	31.3	32.2	.858	.522	Holidays.
Dec. 28 to Jan. 7...	36.1	32.2	.885	.446	Holidays.
1905		WEATHERSTRIPPED NORTH WINDOWS.			
Jan. 7 to 17.....	30.3	29.2	.926	.650	
Jan. 17 to 27.....	30.0	27.3	.886	.589	
Jan. 27 to Feb. 6..	20.4	17.4	.995	.656	
Feb. 6 to 16.....	23.6	22.2	.939	.579	
Feb. 16 to 26.....	32.6	28.6	.923	.518	
Feb. 26 to Mar. 8..	31.4	27.6	.843	.507	
Mar. 8 to 18.....	36.0	34.0	.834	.445	
Mar. 18 to 28.....	50.0	45.6	.712	.262	

The diagram shown in Fig. 11 gives all the above data except the 8 A.M. temperature. Horizontal distances are average outside temperatures for ten days. Vertical distances are the number of gallons (7.64 lbs.) of steam condensed per twenty-four hours per square foot of radiating surface.

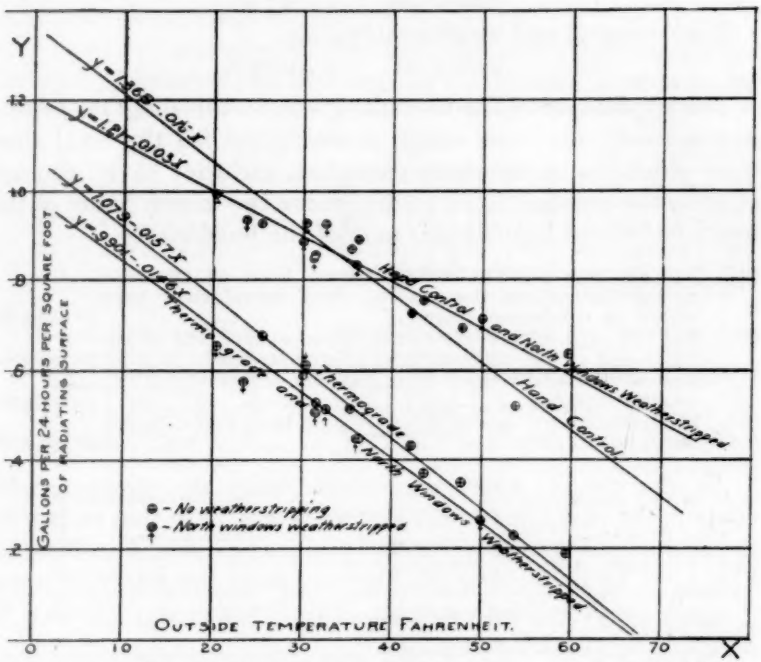
The points fall into two groups, the upper ones relating to hand-control and the lower ones to thermograde-control. Certain of the points are those determined after the windows were weather-stripped.

On the diagram lines are drawn representing the most probable relation between the temperature and steam condensed. Using these average lines for calculation purposes will enable us to determine the value of the thermograde valve and also of the weather-stripping from the standpoint of the amount of steam required to heat the building under various conditions.

It will be noticed first that the thermograde lines cross the base line at nearly 70° and the amount of steam used varies directly at the temperature falls below 70°, that is, with these valves there is real heat regulation. Again it will be noted that, with the windows weather-stripped, the amount of steam

required or the amount of heat used is less by about 10% for the season than if the weather-stripping is not used.

With hand-control, while the amount of heat used decreases as the temperature increases the value does not tend to disappear at 70°, in other words, moderately mild weather means a consumption of much more steam than would be required to do the *necessary* heating. The line showing the average consump-



GALLONS OF WATER CONDENSED PER SQUARE FOOT OF RADIATING SURFACE PER 24 HOURS FOR VARYING OUTSIDE TEMPERATURES (MEAN OF 10 DAYS READINGS)

Fig. 11—Average Results.

tion under hand-control with the windows weather-stripped differs from what might have been expected. Above 33° the heat required is more with the weather-stripping than without, while below 33° the reverse is true.

The formulæ connecting the outside temperature and the amount of steam condensed are as follows, in which y is the gallons of condensed steam per square foot of radiator surface

per twenty-four hours and x is the outside temperature Fahrenheit.

With thermograde-control and without weather-stripping:

$$y = 1.0792 - .0157\,x$$

With thermograde-control and weather-stripping:

$$y = .9901 - .0146\,x$$

Hand-control with no weather-stripping:

$$y = 1.369 - .015\,x$$

Hand-control and weather-stripping:

$$y = 1.21 - .0103\,x$$

The application of the formulæ given on this diagram results in practically the same steam consumption for the total time over which the experiments extended, and they have been applied to the season's work to determine the money value of the four methods of heating this part of the building:—

(A) Had the thermograde control system been on all these rooms throughout the season, there would have been return in condensed steam.....57,650 gals.
(B) Had the same conditions as the above existed and in addition had all the windows been weatherstripped.....51,800 gals.
(C) Had all these radiators been on hand control with no weatherstripping .....93,200 gals.
(D) Had hand control and weatherstripping been used throughout .....98,200 gals.

As the return water was cooler with the thermograde-control, the real value of the system is less, than that shown by the amount of return water, by 5.9%, as this much additional heat must be supplied at the Station before the returned water is again converted into steam. This is taken into account in determining the following figures:

The charge made against the Dormitories for one year averaged .2015 cents per gallon of return water, which covered cost of fuel ($3.00 per ton), labor, repairs and all items except fixed charges which are charged in bulk. on this basis the charges under condition (A) would be $123.44 per year

" " (B) " " 110.92 " "
" " (C) " " 187.80 " "
" " (D) " " 197.87 " "

As the thermograde-valves for all the rooms cost $473.34 more than hand-valves, the advantage to the user is clearly shown from a comparison of the figures just given.

The depreciation and repairs are likely to be slightly more with thermograde-valves, but allowing for these items and interest on extra cost there is still a reasonable advantage in using them.

The cost of weather-stripping the north windows was $90.00 and the saving per year, using it with the thermograde-valves, amounts to $12.52. It must be remembered that these buildings are particularly well built and the outer walls are better built than the average dwelling.

It must be remembered also that the above figures are not the cost of heating the building, as the bleeder system is not

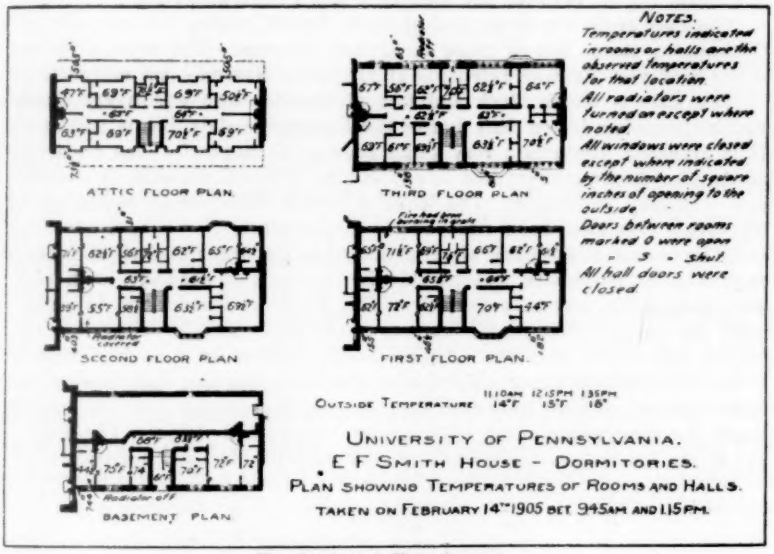

NOTES.
Temperatures indicated in rooms or halls are the observed temperatures for that location.
All radiators were turned on except where noted.
All windows were closed except where indicated by the number of square inches of opening to the outside.
Doors between rooms marked O were open - S - shut.
All hall doors were closed.
ATTIC FLOOR PLAN.
THIRD FLOOR PLAN.
SECOND FLOOR PLAN.
FIRST FLOOR PLAN.
BASEMENT PLAN.
OUTSIDE TEMPERATURE 11:10AM 14°F 12:15PM 15°F 1:35PM 18°
UNIVERSITY OF PENNSYLVANIA.
E F SMITH HOUSE - DORMITORIES.
PLAN SHOWING TEMPERATURES OF ROOMS AND HALLS.
TAKEN ON FEBRUARY 14TH 1905 BET 9:45AM AND 1:15PM.

Fig. 12—Actual Temperatures.

connected to either system, but the data above given is strictly comparable as it covers radiators and returns only in each case.

It may be of some interest to know the condition of these various rooms during the coldest weather of the winter. The rooms are almost invariably aired during the time of cleaning in the morning and, in many cases, windows are kept open in the most severe weather. The diagram herewith, Fig. 12, shows the actual temperature at the time of taking together with such data as may be of interest relating to the occupancy of the rooms.

The average temperature in the attic on December 14, 1904, was 64°, with an outside temperature of 19°F., and in the cellar 69°; and on January 26, 1905, with an outside temperaturt of 14°F., the temperature of the attic averaged 54.7°.

University of Pennsylvania, May 15, 1905.

A NEW VARIETY OF MAINE SLATE.

A new variety of slate has been discovered by Prof. T. Nelson Dale of the United States Geological Survey, in the town of Forks. Somerset County, in Central Maine, between the Kennebec and Piscataquis rivers.

The slate crops out in the bed of Holly Brook, where it is exposed for a thickness of thirty feet or more across the cleavage. The nearest railroad is the Somerset Railway extension at Mosquito Narrows, six miles distant.

The slate is bluish black and fine of texture, with a cleavage surface which shows less luster than that of the Brownville slate, but is still bright. It is graphitic, contains a very small amount of magnetite, has no argillaceous odor, does not effervesce in cold dilute hydrochloric acid, is sonorous, and is readily perforated. The ledge does not show discoloration nor do fragments that have been exposed for fifteen years.

The constituents of this slate, arranged in the order of their abundance, appear to be muscovite, quartz, chlorite, pyrite, and graphite, with accessory tourmaline, zircon, and rutile. This Pleasant Pond slate, to name it after the nearest topographic feature, would prove suitable either for roofing or mill stock purposes. Another ledge of similar slate has been exposed by trenching about a third of a mile away, but this slate shows some false cleavage, at least at the surface. Should that feature continue into the mass the slate would have little or no commercial value. The slate of the Holly Brook outcrop is free from that undesirable characteristic.

AMERICAN SKYSCRAPERS IN ENGLAND.

Some discussion has gone on in England recently over the proposal to introduce the skysraper steel structure in London. B. H. Thwaite, the well-known metallurgical engineer, writes very favorably in London *Public Works* of the American tall building. He says there are in the United States many examples of artistic excellence in the lofty buildings of New York, Chicago and other cities, pointing out also that steel frame buildings are less costly and can be erected more rapidly than any other type of permanent buildings. The London County Council, however, interprets the Building acts as opposing the erection of steel frame buildings in the way that would render them most advantageous. An effort is being made to secure some relaxation of the rules in respect to the use of steel.

(Stated Meeting, held Thursday, January 11, 1906.)

The Finances of Engineering.

By Wm. D. Marks, Ph.B. C. E.

Honorary Member of the Institute.

The brain of the engineer is the dormant intellectual force of to-day, and it should be the dominant one.

For more than 140 years it has been busy in bending the greater forces of nature to the service of man.

I speak of 140 years ago, for about that time Watt told us how to harness the force of heat, and so to-day man's feeble strength is multiplied a million fold by countless steam engines and internal combustion engines.

Faraday has shown us how electricity could be generated by the movement of a copper disc in a magnetic field, and to-day thousands of engineers are busy designing, erecting and operating electric dynamos and motors for the purpose of generating, conveying and utilizing the unseen force of electricity in thousands of places with millions of horse-power. Our railway cars are moved by it, our shops driven by it, and our houses and streets are lighted by it.

In 1792, William Murdock lit his shops with gas distilled from coal, and now we can almost say that the world is lit with coal gas, from vast works designed and operated by gas engineers.

The invention of Watt has been so multifariously adapted by engineers to the necessities of man that we now see vast engines driving enormous ships one-eighth of a mile long at a speed of twenty-five miles an hour across the oceans, or on land find locomotives dragging trains at an average speed of fifty miles per hour half way across our continent; or again moving slower freights on 297,000 miles of track.

The intricate and perfect machinery that drives our ships or drags our trains; the strong, yet wonderfully light bridges which span abysses; the dark tunnels, driven true to a hair through miles of mountains, or under rivers, and the level, smooth paths of iron rails laid upon them are the works of our engineers.

On the grade, in the drawing room, in our shops and in great rolling mills, the engineer's brain is ever thinking and directing vast enterprises.

Our tall iron buildings, rising to dizzy heights, or our deep mines, our vast power and irrigation dams—all are constructed after being thought out by an engineer..

Our water works, our sewer systems, our public improvements on a large scale, all require his thought and his skill, before all else.

His tasks are beset with many difficulties, for nature's obstacles are often hidden, and nature's laws are immutable and merciless.

His knowledge of facts must be large and of the laws of nature exact and profound. His work is on a large scale and his responsibilities are enormous.

Incorrect reasoning, ignorance, or superficial theories on his part are sure to result in great losses of money and often also of life.

Could we prēsent the claims of our engineers upon their fellow men to an inhabitant of another planet unaware of the social organization that binds us, he would decree to them princely rewards for their beneficent labors.

Unfortunately, there is no such impartial tribunal, and instead of being princes of the earth engineers are usually very poorly-paid toilers, who are so much interested in the nature of things with which they deal that they have forgotten the ways of men, particularly those of the employing financiers who find their profit in promoting our great enterprises of which the engineer is the real brain power.

Without a mercenary thought, regardless of his own value, buried in the delight of his work, he toils for a meagre salary, confiding the question of the future success of the enterprise to his employers. If it should not succeed he is usually forced to share the blame of failure, although his engineering work

may have been perfect. If it succeeds his is the jackal's share, the lion's share of the profit going to the promoter of the enterprise.

Very often impossibilities are asked of him, and the whole burden of censure due to financial failure is unjustly thrown upon him.

Engineering in its various branches has nevertheless grown into an honored profession, and to successful engineers is awarded an abundant meed of praise and public recognition.

Why then is it that financially the engineer is so inadequately rewarded for his beneficent services?

May it not be that engrossed in the study of the laws of nature he too often neglects to study the laws of business? Will not his pecuniary rewards be greater if in addition to his scientific studies of them he gives a portion of his thought to a financial investigation of the projects with which he may be connected?

By the word business is meant the various avocations by which men earn or obtain the money required by all to support them and their dependents.

We can divide business into two classes, legitimate and illegitimate. Whenever a man, for a fair profit or wage, furnishes his fellow men with the necessities or luxuries of life he is doing a legitimate business. If a man takes cunning advantage of the weakness, the ignorance, the misfortunes or the vices of his fellow men to obtain more than a just profit or a fair wage from them, then he is doing an illegitimate business.

To this latter class belong most of our very wealthy men, but not our engineers, for their's is a distinctly legitimate business, and for that reason it cannot result in sudden and vast accumulations of money. The engineer must earn his money honestly and slowly.

The honesty of thought and action demanded by his professional work moulds his character so that it is well nigh impossible for him to practice crimes of cunning in illegitimate business enterprises. A conscientious engineer always becomes an honest man.

Every commercial enterprise, great or small, may for the purpose of consideration be divided into three factors:

First—The investment, on which we must reckon the depreciation, the interest and the profit.

Second—The fixed expense, such as clerk hire, stationery, taxes, insurance, and many other items of expense which go on regardless of the volume of business transacted, and with very little variation.

Third—The operating expense, which includes the raw material and the productive labor utilized, and which varies in proportion to the volume of business done.

After having said so much about the characteristics of the engineer, I should first consider him as a commercial or business proposition. Until he is graduated from his college he certainly is only an investment. And when at twenty-one or twenty-two years of age he is thrown on his own resources he may, with good luck, hope for forty years of earning capacity.

Perhaps, however, thirty years is nearer his average working life, and we will use this figure.

The investment in an educated engineer may be put down about as follows:

Living expenses to eighteen years of age	$12,000
College expenses, four years	5,000
Total	$17,000
Depreciation (for thirty years)	$3\frac{1}{3}$ % annually
Interest	5 " "
Profit	8 " "
Total	$16\frac{1}{3}$ " "

If we assume this engineer to hold a salaried position his fixed expense is the cost of his living and his operating expense is nothing.

We then have as an adequate average salary for a technically-educated engineer—

$16\frac{1}{3}$ % of $17,000	$2777
Cost of living (for a single man)	1200
	$3977

Of course he will at first be obliged to begin on a very small salary, but he ought to hope to average $4,000 salary per year

for thirty years, and earn $120,000 in his probable years of usefulness.

If an engineer opens an independent office and becomes a consulting engineer, his fixed and also operating expenses both exist, and his risk of loss and chance of profit both increase.

However, if an engineer prefers to live upon a salary and give only the occasional thought required of him by the commercial side of his various enterprises, $4,000 per year may be regarded as his probable average income for thirty years from purely scientific work.

In America a storm wind of prosperity has been driving all before it for years, and our ever-increasing schools of technology are pouring out civil engineers, mechanical engineers, hydraulic engineers, electrical engineers, marine engineers, sanitary engineers, mining engineers and chemical and gas engineers by the hundreds to join the ranks of our industrial army as real captains of industry, trained to direct it in its honorable toil, but not to manipulate it for personal profit.

Above our line of average earnings rise as brilliant exceptions a Morse, a Corliss, a Roebling, a Brush, an Edison, a Thomson, a Welsbach, and a score of less largely-rewarded technical workers, who, possessing the power to discover in nature new relations between old things are called geniuses, and having conferred vast benefits upon their fellow men by their discoveries (whose value it is impossible to overestimate), have had doled out to them by reason of our patent laws relatively beggarly gifts of a few millions from those who have profited many millions from the exploitation of their inventions in a commercial way.

These financiers, promoters, or exploiters of the public and its needs, own and control our steam and electric railways, our electric light stations and gas works, our fleets of steamships and our great hydro-electric power stations, and hire and pay our engineers to build and operate them. Those of our engineers not having the genius to force a well-earned fortune from nature by a profound and practical study of its laws, must, if they aspire to more than our average modest stipend of $4,000, study the laws of business and the methods and mental processes of our financiers, so frequently miscalled "captains of industry," for in truth the great majority of them are merely

parasites upon the industries which they control, knowing nothing of their practical operations and relying upon engineers to do the producing.

Throwing aside simply lucky men, such as the inheritors of fortunes or the finders of mines as sporadic instances of wealth, and counting as entirely legitimate financiers the organizers and owners of great industries, and which, beginning at the bottom, men of force and genius have built up a great business while directing its details from practical knowledge acquired in working their way from grade to grade until one has reached the top, we have left as yet a great majority of parasitic financiers whose great wealth is the result of methods which should be clearly understood but not practiced by the aspiring engineer. An absolutely cold-blooded and scientific direction of this parasitic type is necessary to our self-protection.

This type is wise because it knows that average men have neither reasoning power nor moral courage. They have only memory and fear of pain. He knows that for the average man the law of the herd is supreme, and he prefers to be wrong with the herd to being right and alone.

This type of financier is not dissipated or unconventional. It scrupulously respects the religious beliefs and the social prejudices of the community in which it exists.

It is economical, because in the pursuit of money it is careful to practice all the economical virtues and to have no expensive or unconventional vices.

It is seldom dishonest, because it usually keeps within the laws of the land, only venturing on legal crimes in times of desperate need.

It is quite as devoid of any sense of justice as it is of practical knowledge of the business from which it reaps a profit.

With truly diabolical cunning it arranges to close the door of opportunity and adequate reward to the real workers and producers, upon whom it relies for service.

With an acuteness amounting to genius it takes advantage of the weakness, the vice, the ignorance and the misfortunes of men to legally rob them of their money. It gains control of the sources of supply of coal, of oil, of transportation, of electricity, of gas, of water, and of the commodities of life, usually through the agency of a corporation, and getting State and

country under its control proceeds by myriads of petty thefts of unjust profits to make counterfeit certificates and bonds (representing no real property) profitable and saleable.

It is self-denying, for it denies itself the pleasure of generous friendship or kindly assistance to men.

This is the type of the conventionally-respectable and parasitic financier of whose doings our daily papers delight to tell us.

Neglecting our criminal financiers, such as Fisk and Gould of the Erie 1872, as too obvious and despicable to require discussion with intelligent men, we will take up our problem from the point of view of the legitimate financier, of the engineer who, having practically and theoretically learned his business by working up from grade to grade, aspires to become a real captain of industry, and by the greatness of his work in organization reap for himself a just and generous reward in money power.

The possession of money creates a commander of an industrial army, and if this commander is wise, just, unselfish and temperate in his acts, his well-earned wealth makes for the good of all men who serve him, and for the advancement of his community.

It may be a work of supererogation in a discussion of finances to devote so much time to a discussion of the types and methods of financiers before taking up the statistical side, but stripping off all cant, it is a fact that the man who is scrupulously honorable and fair in his dealings with all men imposes upon his abilities a burden which the merely legally honest and yet unfair man does not carry in the struggle for money.

The really honorable man must therefore work harder and be satisfied with less than prominent financiers, even though his energies may possibly make him a millionaire.

It is, too, exceedingly important to recognize the facts that all wealth is not the result of dishonor, and that it is impossible, since all men are not equals in ability or opportunities, for all men to have equal possessions, or positions of authority, or leisure for recreation.

The laws of nature prohibit such utopian dreams, for they demand work of all us for the development of man's better faculties, and it is by work alone that they can grow and expand.

Then, too, we all of us have a limited susceptibility of education. We must divide our vocations and by iteration of work in our own specialty become adepts in it of greater skill than otherwise would be possible, and then in turn rely upon adepts in other vocations for the needs we ourselves do not supply.

It appears as if nothing could be more foolish than to fail to recognize and accept the relentless laws of nature against which the puny efforts of man avail nothing.

However good, however delightful, however humane our theories may be, unless nature consents and assists they can result in nothing but failure.

To succeed in any enterprise we must organize, we must recognize and obey well defined laws and principles and we must have superiors and inferiors in our industrial armies—and may I add our superiors should only be honest veterans, whose diligence and ability shown in every department and grade of their commands has proved them worthy officials.

It will be rather difficult to discuss the cost of construction and operation of the various forms of engineering enterprises in our limited space, but a few selections will open the gates to you and perhaps interest you sufficiently to lead you to a reference to the authorities quoted which will give you details impossible to go into here.

STEAM RAILWAYS.

The report of the Interstate Commerce Commission for June 30, 1904, gives the total mileage of railway tracks in the United States, wherever located or however used, as 297,073 miles, and their length of road bed as 212,243 miles.

Total capital stock issued	$6,339,899,329
" funded debt	6,873,225,350
" railway capital	$13,213,124,679

The total length of road bed of a steam railway is not a criterion of its cost, for it may have four tracks and vast freight yards and stations and miles of siding.

It may be built regardless of cost of construction, as is the Pennsylvania low-grade freight line from Harrisburg to Atglen, where 4,000,000 cubic yards of rock excavation some-

times are required per mile of road bed, or it may be built like the many tens of thousands of miles of single track stretching across the prairies of Mississippi Valley, which can be best described as two streaks of rust on a mud bank, traversed by few trains.

But the total length of single track, wherever located or however used, will give us a rough index to the difference in construction cost of a four-track, a double- track, and a single-track road, and also amply cover the extra cost of sidings and freight yards.

From our figures, we find that every mile of railway track in this United States is capitalized at about $44,480, whatever its real cost may have been.

To find this real cost is somewhat difficult.

Suppose we take the oaths of the railway officials to the tax gatherer as to taxes and reported by Interstate Commerce Commission June 30, 1904:

AD VALOREM TAXES JUNE 30, 1904.

On values of real estate and personal property....	$43,410,020
" " stocks, bonds, earnings, etc.....	6,305,807
" " property not used in operation.....	1,324,808
Total (omitting special taxes).....	$51,040,635

Delaware, Maine, Maryland, Minnesota and Vermont are the only States not accepting the basis of ad valorem taxation as their principal factor in levying taxes.

One per cent. is certainly as low an average tax rate for State or county taxes as can be reckoned upon and will fix a maximum valuation of $5,104,063,500, or about $17,520 average value of total construction property and equipment per mile of single track wherever built in this United States.

Perhaps this is not convincing. Perhaps it will prove more convincing to select an average State, such as Indiana, and give the tax valuation of its State Commissioners for 1904 upon all its steam railways.

We find returns of trackage and values as follows:

Main track	6,730.55	miles
Second main track	615.69	"
Side tracks	2,846.17	"
Total of all tracks	10,192.41	"

And we have as their tax valuation upon all tracks, rolling stock and improvements upon right of way $165,863,367, or $16,274 per mile of track.

A careful study of the details of the Report of the Tax Commissioner of Indiana for 1904 will prove convincing as to its fairness in stating the truth concerning the true cost of Indiana railways.

If we take Indiana as an average railway State we obtain for 297,073 miles of single track $4,834,666,002 as the total cost of all the railways of the United States.

Without going into the details here a most liberal and careful analysis of the excellent Report of the Massachusetts State Railroad Commissioners for 1903 would appear to prove the average cost of construction and equipment of a mile of single track to be less than $25,000. In Massachusetts the car equipment is very large ($10,000 per mile), because the manufacturers are many and the population dense, so we can regard this figure as a maximum average cost per mile of single track for every State.

Perhaps a detailed estimate of cost of a single-track railway will make its cost clearer and still more convincing.

We will at first omit the extra costs of urban right of way, of long bridges, of heavy rock cuts, and of extraordinary tunnels and excavations. We will, however, allow an average of 10,000 cubic yards excavation at 35c, or $3500 per mile. If excavation and embankment are balanced in each mile we have 102 cubic feet per foot of track or an average cut or fill sixteen feet wide and six and a-half feet deep, which of course you will recognize as an excessive allowance.

ESTIMATE OF COST OF ONE MILE SINGLE TRACK TO THE TOP OF THE RAIL.

Spikes, four per tie, 5½x $\frac{5}{8}$ 5,280 lbs., @ 4c	211	
Preliminary legal expenses and right of way		$700
Surveyors	$ 100	

Grading	3500	
Ties, 2640, @ 50c	1320	
Rails, 70 lbs., @ $30 (118 tons)	3540	
Joints and bolts, 352 @ $2	704	
Switch irons	150	
Road ballast, 10 ft. x 2 in. (50c per cu. yd.)	652	
Fencing wire with posts	480	
Crossings	20	
Labor laying track	1000	
		11,577
Architectural work—stations, shops and houses		1,500
Extraordinary expenses—bridges, tunnels, etc		2,000
Total for construction of one mile		$14,877
Equipment from State tax Comm. Indiana		1,781
Total cash cost of construction and equipment		$16,658

The item $1,781 is obtained by dividing the assessed value of all rolling stock on Indiana railways by their total of single track 10,192 miles. The items of $1,500 and $2,000 cannot be verified as completely as others, but they are ample, and the majority of our nearly 300,000 miles of single track has never benefitted by the expenditure of this $3,500 item.

We have endeavored to get at the real cost of construction and equipment of average railways, and reached the following results:

(1) From the taxes sworn to by railway officials ..... $17,250 per mile
(2) From the Report of the Indiana Tax Com. 16,274 " "
(3) From a careful and overloaded estimate.. 16,658 " "

Before this I have stated to you that Massachusetts with its hilly and rocky topography might average a cost of some where near $25,000 per mile of single track, and now you also see that $17,500 per mile cost is a high average estimate for the vast net-work of railways that covers the Southern States and the Mississippi Valley. $44,480 per mile is the average capitalization found. This is divided up as follows:

Funded debt per mile	$23,137
Capital stock " "	21,341
	$44,478

Comparing these figures with the average cost of construction and equipment, $17,500, we find that about 76% of the par value of our railways' funded debt has been utilized for their creation and that the sale of stock has not been required at all.

Remember, I am dealing with averages. Fortunately there are exceptional railways in which both bonds and stocks have been paid for and the money legitimately used for the purpose of creating them, but they are few.

On the average the capital stock of our railways has no more real basis as a token of labor or of existing property than a counterfeit bank note, and the par value of our bonds is greater than the cash cost of our railways by about 33%.

You ask how can this have come about? I answer: There is no more facile instrument for the cunning man than a corporation allowed to work in secret.

When an average railway is built, a construction company is generally formed, which agrees to build it for its securities, and doing so receives them, and placing the bonds, through dealers in securities, reserves all or a portion of the stock for itself.

The actual cost spent on a railway appears to average 76% of the value of the bonds, the remaining 24% goes as profit to the bond broker and his allies in the construction company, unless the bonds are sold below par, say at 90%, and then the profit is reduced to 14% cash and the speculative profit which may be obtained from the sale of as much stock as they may be able to retain for themselves.

If we are extremely liberal with these railways we might allow $20,000 per mile of single track, and then it would appear as if 86% of the par of the bond issue, $23,137, has been appropriated for construction and equipment.

Careful appraisements of the cost of reproduction of existing railways have been made by the State of Texas, in 1895. The best and most careful engineers, valuing the Texas railways mile by mile, obtained an average of $18,000 per mile of road bed for all construction, equipments and investment.

It would have been clearer and fairer if they had given the cost per mile of single track, wherever laid or however used, for their railways, which is much less.

Usually after a few years of operation a railway is consolidated with or purchased by some larger system of railways and

on this account a new issue of securities is usually born and sold.

Of course there are many other causes of the existing status of our railways, but I have given you the usual method of inflation and the main cause of their enormous over-capitalization.

These methods have also been applied to almost every class of industry operated by corporations in this country. Electric railways differ from steam railways because of their more costly construction of power stations and transmission systems, and also because being sometimes built in the busy thoroughfares of a metropolis, or again over the fields and country roads as an interurban railway, they differ widely in first cost. From the special reports of the Census Office, 1902, I obtain the following capitalizations of electric railways:

FOR URBAN CENTERS PER MILE OF TRACK.

Population	500,000	and	over	$209,162
"	100,000	"	"	113,026
"	25,000	"	"	63,197
"	25,000	"	less	38,445
Interurban railways,			fast	52,371
"		"	ordinary	50,313

From practical experience one-half of their capitalization in cash would appear to me amply sufficient to build any of these different classes of electric railways.

Ninety-six thousand two hundred and eighty-seven dollars per mile was the average capitalization of all the electric railways in the United States in 1902, but this figure is of no value, for the demands of locality vary too widely to permit of arranging electric railways as we do steam railways.

The special report of the Census Office, 1902, upon central electric light and power stations is instructive.

The actual cash cost per installed horse-power of the 10,000 H. P. Philadelphia Edison Station did not exceed $250, and in many cases of smaller and less massively-built stations it goes as low or lower than $150 per H.P., including the distribution system.

The total capital stock and funded debt of all these stations in 1902 was $627,515,875, and the total horse-power installed

in dynamo capacity was 1,743,000, giving us an average capitalization of $426 per horse-power. The cost of construction per horse-power of electric light and power stations should vary widely, and it does.

Perhaps $150 per horse-power can be called an average for the smaller stations of the Mississippi Valley and $450 for the remote localities of the far West; $250 per H.P. a proper average of all. A large investment per horse-power can be afforded for hydraulic over steam power, and that has contributed to the occasional larger first cost of stations in the far West.

There prevails however the same general inflation of capitalization due to "water" in the stock in both electric light and gas companies. Of course my figures are averages only, and averages are often widely departed from in individual instances, but still I trust I have made my picture clear and you can see the patient engineer striving to reduce the cost of construction and struggling with operating costs, while the industrious promoter overcharges the public as much as it will stand and sells as many watered securities to it as he can get it to take.

The receipt for making a modern parasitic millionaire can be inferred from this. Create a corporation, preferably under the obliging laws of New Jersey, and be careful to work it in secret. Hire as many engineers as are necessary for all of its legitimate business functions and the direction of productive labor. Arrange that the finances shall be controlled by a board of cunning financiers, skilled in illegitimate business. Get out as many bonds and as much stock in excess of real cost as the public can be pursuaded to buy. Arrange if possible for a monopoly, and overcharge the public as much as it will bear for the product, whether it be ton miles, passenger miles, kilowatt hours, gas, or iron or oil. In a short time your parasitic millionaire will emerge. You hear of a new one in New York every day.

I am not preaching a sermon to you on the ethics of this procedure. I am only giving you, to the best of my knowledge, a cold-blooded dissection of this modern "Chevalier d' Industrie" of the United States.

Bear in mind that there is a limit to the producing capacity of most men and that great geniuses (such as an Edison) only

can honestly and rightfully grow colossally rich by honest work. Bear in mind that if you wish to keep, and to have others keep, what they have honestly earned you must not be satisfied with your own rectitude, but also insist that all with whom you deal act honestly, however disagreeable the task may be.

The recent awakening of the public conscience bids us all hope for better conditions than have existed for many years, for if our present methods of corporate legal theft are not stopped all the property in the United States will soon be in the hands of gilded thieves.

THE ZAMBESI POWER SCHEME.

Prof. W. E. Ayrton in the London *Times* criticizes severely the Zambest power scheme, the details of which have recently been given in these columns. He denies the possibility of such a scheme being commercially successful, and condemns the comparisons made between the power schemes at Victoria and Niagara, as the latter only delivers electrical energy over a distance of 30 miles while the former proposes to deliver it over 745 miles. At present the Rand consumes about 150,000 hp at a cost of something like $100 per year per horse power. Niagara sends 24,000 hp to Buffalo, 30 miles away, and sells it at 14 cents per horse-power-year, an eight-hour customer, which is equal to $125 per horse-power-year. There is a plentiful supply of coal in the neighborhood of Johannesburg, and estimates have been obtained and accurate analysis made of about 20 different kinds of coal, giving the specific gravity and the percentage of carbon, ash, volatile matter, coke, as well as the evaporation factor, with the result that at a price of $2.60 to $3.00 a ton excellent coal can be delivered on the Rand itself. How is it possible, therefore, asks Prof. Ayrton, to "transmit electric energy 745 miles and sell it more cheaply than it can be obtained from coal on the spot?" He also points out the dangers from native interference with the line, and summarizes his objection to the scheme in the sentence that "such lengthy transmissions, more than three times as long as have ever yet been made, because more than three times as long as even the enterprising Americans have ever yet considered commercially possible, could cretainly never succeed in such an unsettled country as South America."

ELECTRIC FURNACE PROCESSES.

Under the heading "Recent Electrochemical Development," the following interesting account of the latest experiments with electric furnaces appeared in the *Electrical World and Engineer*, December 16, 1905:

The revelation in workshop practice, brought about by the arrival of high speed tool steels, has been intimately connected with the revolution

in the ferroalloy industry due to the introduction of the electric furnace. It is only in the electric furnace that most high percentage ferroalloys, low in carbon, can be made. The only process which the electric furnace industry has to compete with is the aluminothermic method, using aluminum as the reducing agent (instead of carbon in ordinary electric furnace practice). By the aluminothermic method several carbon-free metals, like chromium, &c., are produced. The feature which distinguishes both the electric furnace and the aluminothermic methods from the blast furnace process is that very high temperatures may be easily obtained in the former two methods. Nevertheless, it appears that so far it has been impossible to reduce some extremely refractory oxides, like that of titanium, to the metallic state by either of the two methods. It is not strange that to reach this goal a combination of both methods is now being tried. The recent American Electrochemical Society paper of O. P. Watts described experiments made in this direction by adding the heat of the electric arc to that of the aluminothermic reaction.

A. J. Rossi, the pioneer of ferrotitanium, is also working in a similar direction, as shown by a patent recently granted to him. The feature which distinguishes his method from the aluminothermic process is that he does not use finely powdered aluminum, but scrap or pieces of aluminum in any form, which he introduces first into the electric furnace. When the current is turned on the aluminum is fused. The refractory oxide to be reduced is then introduced into the fused bath of alumnium. Thus not only the electrically generated heat is utilized, but also the oxidation heat of the aluminum (of course minus the reduction heat of the oxide).

A new form of electric furnace for the production of calcium carbide has recently been patented by Appleby. It is chiefly characterized by a movable bottom, so that constantly fresh portions of the charge are introduced into the zone of the stationary elestrodes.

ARTIFICIAL GRAPHITE.

The International Acheson Graphite Company, Niagara Falls, N. Y., with the recent competition of a large extension, equipped with the most modern electrical and mechanical appliances and machinery, has doubled the capacity of its plant for creating graphite in the electric furnace and has closed a contract with Niagara Falls Power Company for another 1000 horse-power of electrical energy in addition to the 1000 horse-power previously used. The commercial importance of this artificial graphite may be estimated from the fact that the United States geological report for 1904 states that for that year the value of Acheson graphite made in this country amounted merely to $341,372. New York State, which is considered rich in deposits, according to the official report of 1904, produced natural graphite worth $119,509. Acheson graphite is largely used in the manufacture of metal protective paints, dry batteries, stove polish, packing and as a lubricant. The electrochemical processes also consume an extensive supply.

Section of Physics and Chemistry.

Read at the Stated Meeting held Thursday, November 2, 1905.

The Administration of the Imported Food Law.

By W. D. Bigelow.

Chief, Division of Foods, Bureau of Chemistry, United States Department of Agriculture.

I believe that posterity will refer to the present time as a period when the public conscience was awakened to an unprecedented extent—a period when the people at large took an active interest in the establishment of right, and the overthrow of wrong. Illustrations of this tendency occur within our everyday life. We have had numerous instances in the political world during recent years of party lines giving way to vital questions of right and wrong. The mass of the population takes a deeper and more intelligent interest in the affairs of the nation than ever before, and the individual probity of public officers has attained a new and greatly increased importance. In the elections of a year ago the people took occasion to express in an unmistakable manner their confidence or lack of confidence in the integrity of individual candidates, and the executives of several States and of the nation were elected by majorities so great as to represent the confidence, not of a dominant party, but of the entire people, in the personal integrity of certain individual citizens.

This disposition is not characteristic of any municipality or State but extends throughout this country and throughout the world. I believe the effort that is being made towards national, state, and municipal purity in administrative measures is characteristic of the age, and must be productive of important far-reaching results. I am aware that the opinion is frequently expressed that we have fallen upon evil times, and that

the corruption that has at times been found to exist in State and municipal organizations, and in corporations entrusted with the control of public utilities, as an evidence of the inability of our form of government to meet the situation that confronts it. It is my opinion, however, that such is not the case, but that the publicity now given to corrupt conditions, wherever they are found—whether general or local, whether in public affairs or in the affairs of corporations controling public utilities or administering funds held in trust—is due to the determination of the people at large that such evils shall be corrected. The public has been awakened and interested to an unprecedented extent, and is in a better position than ever before to remedy conditions of which it does not approve.

If this be true, it is but natural that greater attention should now be devoted to our food supply than was formerly the case. It is but natural that the public at large should take an interest in the wholesomeness of our foods as well as in the larger moral question of fairness and honesty in our commercial relations.

As a matter of fact, we are more interested and better informed with respect to the nature and quality of the food we consume than ever before. We are studying the methods for the preparation of foods and the quality, digestibility, nutritive value and wholesomeness of the finished article. We are investigating methods for their transportation and for their preservation, both in their natural state and in an advanced state of manufacture. We are acquiring information regarding the relative digestibility of various foods and the relative wholesomeness of substances used in their preparation. We are establishing standards of composition and studying methods for the determination of the purity of foods and for the detection of adulterants. We are studying these questions in Federal, State, and municipal laboratories; in food and dairy commissions, experiment stations and boards of health; in schools and colleges; in popular lecture courses; in farmers institutes and womens clubs; in factories and grocery stores; and in the home. We are assisted by information circulated by the public press, though hindered by sensational articles and misleading advertisements in the same agency. We shall not master it in a year—we may not in a generation—but we are making progress.

Until less than twenty-five years ago no attempt was made in the United States to control in any way the character or quality of our foods. A general food inspection law was enacted by the thirteen original States, but from the character of that legislation it is apparent that its enforcement was not contemplated. In 1883, the first practicable food inspection law of the United States was enacted by the State of Massachusetts. This law was immediately put into effect and has been enforced regularly and uniformly from the date of its enactment. Since then other States have enacted and enforced food laws, until at the present time twenty-five of our States and Territories are seriously attempting to regulate the character and quality of the foods sold in their markets.

In 1881, the Bureau of Chemistry—then the Division of Chemistry—of the United States Department of Agriculture began the study of the question of food adulteration and since that time has given much attention to the subject. Until 1898 we studied foods in general and no particular attention was given to the origin of these foods. Until that time the samples examined in the laboratory were secured in the open market and were intended to represent the foods sold in the retail trade, no attention being given to the locality of their production. During the summer of 1898, however, the study of imported foods was begun. Samples of a number of classes of foods were secured from the Customs officers at the various ports of entry and examined. Additional samples of foods, alleged to be imported, were secured in the open market and the results of their examination were compared with those obtained at the ports of entry. On March 3, 1903, Congress enacted as a feature of the appropriation act of the Bureau of Chemistry a law relative to imported foods. This law has been slightly amended in succeeding appropriation bills. As now enforced the portion of the law relating to imported foods authorizes the Secretary of Agriculture—

"To investigate the adulteration, false labeling, or false branding of foods, drugs, beverages, condiments, and ingredients of such articles, when deemed by the Secretary of Agriculture advisable, and report the result in the bulletins of the Department; and the Secretary of Agriculture, whenever he has reason to believe that such articles are being imported from foreign countries which are dangerous to the health of the people of the United States, or which shall be falsely labeled or branded, either as to

their contents or as to the place of their manufacture or production, shall make a request upon the Secretary of the Treasury for samples from original packages of such articles for inspection and analysis, and the Secretary of the Treasury is hereby authorized to open such original packages and deliver specimens to the Secretary of Agriculture for the purpose mentioned, giving notice to the owner or consignee of such articles, who may be present and have the right to introduce testimony; and the Secretary of the Treasury shall refuse delivery to the consignee of any such goods which the Secretary of Agriculture reports to him have been inspected and analyzed and found to be dangerous to health or falsely labeled or branded either as to their contents or as to the place of their manufacture or production, or which are forbidden entry or to be sold, or are restricted in sale in the countries in which they are made or from which they are exported. * * * *(Section of Appropriation Act of March 3, 1905.)"*

This law became effective on July 1, 1903, and was immediately enforced. The investigations of imported foods that had already been made by the Bureau of Chemistry made it possible for us to immediately begin intelligent work upon this subject. It was desired to enforce the law as completely as possible, and for this purpose it became necessary to secure complete information respecting shipments of foods to the United States. It is a matter of general information that all shipments of merchandise sent to this country, valued at $100 or more, must be accompanied by an invoice certified to before a United States Consular officer. Arrangements were made with the State Department that copies of all such invoices relating to food products should be sent from the various consulates directly to the Bureau of Chemistry and should be accompanied by a declaration of the country in which the products were grown, from which they were exported, and of the presence or absence of added preservatives and coloring matter. The following is a copy of the declaration which is required to accompany all invoices of food products sent to the United States:

DECLARATION OF SHIPPER OF FOOD PRODUCTS.

1. Seller or owner, or agent of seller or owner.

2. Country.

3. Town and Country.

I, the undersigner, am the 1—— of the merchandise mentioned and described in the accompanying consular invoice. It consists of food products which contain no added substances injurious to health. These food products were grown in 2—— and manufactured in 3—— . They bear no false labels or

4. State coloring matter used, if any.

5. State preservatives or other articles used, if any.

6. Place.

7. Date.

marks, contain no added coloring matter except 4——, or preservative (salt, sugar, vinegar, or wood smoke excepted) except 5——, and are not of a character to cause prohibition or restriction in sale in the country where made or from which exported.

I do solemnly and truly declare the foregoing statements to be true, to the best of my knowledge and belief.

Dated at 6—— this 7—— day of————, 190 .

(Signature)————————

Arrangements were also made with the State Department by which special food invoices were required even for consignments of foods valued at less than $100. By means of these invoices the Bureau of Chemistry was kept informed of all shipments of food products sent to the United States. During the first year of the enforcement of the law all work relating thereto was conducted in Washington. The invoices referred to above were examined daily, and when an invoice was found which it was desired to inspect, a request was made on the Secretary of the Treasury that the Collector of Customs of the port of entry to which that shipment was consigned be instructed to send a sample of stated size to the Bureau of Chemistry. This sample was then examined and when found to conform to the law a statement of that fact, with the request for the release of the shipment to the consignee, was forwarded to the Secretary of the Treasury, and by him transmitted to the Collector of Customs. When a shipment was found to be contrary to the law, considerable leniency was shown at the beginning in order that foreign shippers and American importers might have time and opportunity to become fully acquainted with the law. It was desired to interefere with commerce as little as possible. The earlier shipments which failed to conform to the law only in the fact that they were not correctly labeled were admitted without prejudice to future decisions and the importers were notified that they were in violation of the law. Later, importers were permitted to re-label shipments with pasters, on which was given a declaration correcting any omission or misstatement by reason of which they failed to conform to the law.

During the first year of the enforcement of the law it was found that the delay occasioned by transmission of samples to Washington was so great as to cause considerable inconvenience to importers. Accordingly, in September, 1904, a laboratory was established in connection with the Appraiser's Stores in New York for the inspection of the foods imported at that port. The organization of this laboratory was found to greatly expedite the law in a much more complete and thorough manner. As a result of our experience in that port, laboratories have been established during the last few months in five additional ports of entry—San Francisco, Boston, Philadelphia, Chicago, and New Orleans. By far the majority of foods imported into the United States came in at these six ports. Shipments arriving at ports at which no laboratories have been established are subjected to the old system of inspection, that is, the invoices are received at the Bureau of Chemistry and samples are sent directly to the Bureau, or to the nearest laboratory, from the ports of entry.

By far the greatest part of the shipments of food products are now inspected at the port laboratories referred to above. It is believed that in this connection a description in some detail of the methods employed in inspection will be of some general interest.

At the time of, or before, the entry of the vessel bearing a consignment of goods, the importer or his broker calls at the Customs House, delivers his copy of the consular invoice, on which the shipment or shipments in which he is interested are described, and advances the required amount in payment of the estimated charge for duty. After passing through the necessary channels in the Customs House, the invoice is sent to the Appraiser's Stores, where it is finally referred to the examiner, who is charged with the valuation of the shipment. While in the hands of this examiner, the representative of the Department of Agriculture inspects the invoice and decides whether or not it will be advisable for him to inspect the shipment it represents.

All invoices of food products going through the port must pass through the hands of the food inspector. It may be that he will immediately recognize the manufacturer as one whose goods have frequently been inspected and always found to con-

form to the law. It may be that the goods represented on the invoice are such as he knows by experience usually, and perhaps always, conform to the law. If, for any reason, the inspector decides that it is not advisable to examine the goods described on the invoice, he stamps the invoice with the words "No Sample Desired by the Department of Agriculture." If he considers that the products are of such a nature that they should be examined in the laboratory, he attaches to the invoice a sample tag like the following:

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY.

FOOD PRODUCTS.

Food Laboratory No._____ Sample Requested.

Marks and Nos.	Article	Amount

Sample { ordered / forwarded } _____, 190

_____
Examiner.

_____
Chief, Food Laboratory, Port of_____

On this is indicated the particular case from which a sample is to be taken and the amount of sample that is desired. If he is undecided and cannot determine without seeing the goods themselves whether it will be advisable to examine a sample in the laboratory, a detention tag like the following is attached to the invoice:

FOOD PRODUCTS.

INVOICE DETENTION SLIP.

Inspection deferred. Invoice to be detained by, or returned to, examiner of food porduct item upon completion of examination of other items therein.

.....
Chief, Food Laboratory.

For the convenience of those handling the invoices, the "detention tag" is yellow, while the "sample tag" is white. The examiner is instructed that when a shipment of foods described by an invoice bearing a yellow detention tag reaches him, he shall notify the Chief of the Food Laboratory of the Department of Agriculture, and give him an opportunity to inspect the shipment on the floor and decide whether a sample is desired or not. The "detention tag" is especially useful in the case of foods on whose labels a declaration of some ingredient or ingredients is required. Frequently the inspector only requires to see the label to determine whether the declaration has been made. If it has not an analysis is necessary to determine whether the declaration should have been made or the nature of the goods has been changed since previous inspections. After seeing the shipment the inspector decides whether or not a sample should be taken for the food laboratory. He then tears off the yellow detention tag, and either stamps the invoice with a statement that no sample is desired, or affixes a sample tag, requesting the amount of sample he desires.

It is thus seen that eventually the inspector marks each invoice of food products, either by stamping on it the statement that no sample is desired, or by affixing to it a tag requesting the amount of sample that shall be sent to the laboratory. On the arrival of the goods represented by an invoice that is marked with a sample tag, the examiner forwards a sample to the laboratory. When the shipment is appraised on the docks, as is done with certain articles, the examiner sends an order for a sample to the proper officer. He then cancels the word "ordered" or the word "forwarded" and signs the form. When the examiner has finished with the invoices they are returned to the chief clerk of the Appraiser's Stores, who again must see that all invoices of food products have either been stamped or tagged, as indicated above, and that all tagged invoices are properly endorsed by the examiner.

With the exception of those packages sent to the Appraiser's Stores for appraisement with respect to duty (usually one-tenth of the shipment), and from which the samples used by the food laboratory are taken, shipments of imported foods are delivered immediately to the importers. This has been found necessary as because of the magnitude of the shipments it is im-

practicable to store them until the completion of the analysis. Moreover, the expense of cartage and storage would be considerable and is to be avoided on that account. Again, importers desire to be permitted to use their goods at as early a date as possible, and it is a great convenience to them to have them in their possession in order that they may forward them to their customers, when desired, as soon as the inspection is completed. When a sample is taken for analysis the appraiser of merchandise notifies the importer of that fact and requests him to keep the goods intact until further notice. On the completion of the examination the chief of the food laboratory communicates with the importer and notifies him of the result of the inspection. If the goods have been found to comply with the law, the importer is then at liberty to dispose of them. If the examination indicates that the shipment does not comply with the law, the collector of customs is notified and immediately takes measures to secure the return of the shipment to the customs warehouse, in order that it may be shipped beyond the jurisdiction of the United States. In case of an apparent violation of the law, the importer is also notified of that fact, and that the case will be decided on a certain date at the port laboratory, when he may be present and present evidence. This date may be deferred at the request of the importer to enable him to secure such evidence. Information relative to any particular shipment is given only to the importer. No information is accessible to any importer regarding the inspection of goods consigned to a competitor. If it should happen, therefore, that a mistake were made and goods wrongly considered to be in violation of the law, the matter can be rectified by reviewing the case, in response to a protest from the importer, and no injury is done to the reputation of the importer or of the goods in question.

Immediately on complaint of an analysis from which it appears that a shipment of food is in violation of the law, a brief report of the cause on a blank form prepared for that purpose is made to the Bureau of Chemistry in Washington, accompanied by a sample of the shipment. The work is immediately repeated in Washington, the result reported to the port laboratory and the action recommended by that laboratory confirmed or reversed before the time set for final hearing of the

case. In this way all possible safeguards are thrown about the work connected with the enforcement of the law and the interests of importers are protected in every practicable way.

When we consider the large number of shipments inspected in all of the ports, it is apparent that all phases of the work should be systematized as completely as possible. When a sample is received at the laboratory it is entered in an index book kept for that purpose and also on one of the several forms of report cards. The information descriptive of the sample is entered on duplicate cards, one of which is made as a carbon copy. On the completion of the analysis the analytical results are entered on the cards and one copy is filed on the port laboratory and the other forwarded to Washington with a recommendation as to the final disposition of the goods and the reason therefor endorsed on the back. The analytical results obtained in the Washington laboratory are entered on the same card in parallel column and the card filed according to the manufacturer. It is thus a simple matter to determine at any time whether a given manufacturer is shipping the same quality of goods to the different ports of entry, or whether the results obtained in the various laboratories of the Bureau upon the goods of a given manufacturer are consistent with each other. A copy of the results of the Washington laboratory is also forwarded to the port laboratory upon a separate card, with an endorsement confirming or reversing the action recommended by the port laboratory. I give below copies of the report cards employed in this work. They are so arranged as to permit the recording of a quite complete analysis of the different classes of products for which they are adapted, although in ordinary inspections a small number of determinations is made. It is only under exceptional conditions, when some circumstance casts suspicion on a shipment, that a more complete analysis is made:

Port No..... Label.....

F. I. No.....

Consignee .....Marks

Manufacturer.....Entry.....C. H. Inv.....

Steamer .....Received.....Action.....

	Port Lab.	Washington Lab.		Port Lab.	Washingt'n Lab.
Sp. gr. (15.50°C)			Free acids		
Index Refrac. (15.5°C)			Halphen test		
Sp. Temp. No.			Villavecchia test		
Iodin No.			Renard test		
Sap. Val.			M. Pt. Arach. acid		
M. Pt. Fat. acids			Adulterant		

Port No..... Label.....

F. I. No.....

Consignee .....Marks

Manufacturer.....Entry.....C. H. Inv.....

Steamer .....Received.....Action.....

	Port Results	Washington Results		Port Results	Washingt'n Res'ts
Solids (per cent)			Reducing sugars before inv. (per cent.)		
Ash (per cent)			Reducing sugars after inv. (per cent.)		
Acidity (cc N. alk. per 100 grs.)			Coloring matter		
Polarization direct at °C degrees)			Salicylic acid		
Polarization invert at °C (degrees)			Benzoic acid		
Polarization at 86°C (degrees)			Fluorids		
Sucrose (per cent)			Sulphurous acid (per cent total)		
Glucose (per cent)					

The enforcement of this law has had a decided influence upon the character of the foods imported into the United States. Many shippers are sending a higher grade of produce than before. Others have altered their labels or added to them a declaration of some foreign substance.

When the law went into effect much of the oil imported into the country under olive oil labels was found to be mixed with peanut, sesame, or cotton seed oil. During the first few months of the enforcement of the law, numerous importations

of oil so adulterated were received. It was frequently necessary to notify importers of the unsatisfactory character of the goods they were importing, and in a number of cases shipments of adulterated olive oils were re-exported. At the present time such practices do not obtain. Although the inspection of imported olive oil still continues, only one recent importation was found to be adulterated with other oils. The same statement is true in a general way of many other classes of foods. It has been held that canned goods consisting of fragments of articles ordinarily imported whole or in symmetrical parts must not be labeled in such a manner as to deceive the consumer as to their nature. For instance, canned mushrooms are supposed to consist of the whole fungus, including top and stem. It has been the custom to bring into the country a grade of fragments and culls of mushrooms. These were labeled "Hotels," and sold at a low price. The Department has decided that this article should not be labeled simply "Mushrooms," but the label must also bear the words "fragments and scraps," or "pieces and stems."

The Department has decided that the label must declare the presence in the foods of all added substances having in themselves no food or condimental value. For instance, it has been decided that canned peas and other legumes greened with copper shall have the words "Colored with sulphate of copper," or "Prepared with sulphate of copper," printed on the label in prescribed type. It has been held by manufacturers that the practice of using copper for this purpose was familiar to all consumers, and that such a declaration was superfluous. In this connection, however, it is of interest to note that vegetables green with copper are not commonly used in the countries of their manufacture, but that they are chiefly prepared for the English and American trade. At the present time all importations of such products are labeled with the declaration mentioned above.

When this law went into effect it was freely predicted that its enforcement was impracticable. It was said that the enforcement of the law would antagonize manufacturers, importers, and dealers, and that numerous interests would speedily combine for its repeal. It was not to be expected that the law would command the aproval of all foreign manufacturers and

American importers. It is a great satisfaction to note, however, that the majority of importers endorse the law and approve of its enforcement, and that manufacturers are complying with its provisions without protest, only requesting an opportunity to dispose of goods that have already been packed. It was said that manufacturers would never be willing to declare the presence of preservatives or coloring matter in food. At the present time, however, the great majority of shipments coming into this country have the required declaration of these substances plainly stated on the labels, and some manufacturers have discontinued the use of preservatives and coloring matter rather than to make such a declaration, and find it entirely practicable to market their wares without such addition. The following illustrates the attitude of the majority of American importers:

A shipment of lemon oil was inspected at the port of New York and found to be adulterated with turpentine and mineral oil. The importer was notified that the shipment did not comply with the imported food law and that it should be re-shipped beyond the jurisdiction of the United States. He expressed himself as highly pleased with that disposition of the goods. He stated that he bought the oil as a result of bids upon specifications for pure lemon oil of high grade. He had supposed it to be as represented and had been surprised to have a shipment rejected by one of his customers a few days before because it was not suitable for use in the preparation of flavoring extract. The importer expressed himself as being anxious to handle only the highest grade of products and as being pleased with the protection afforded by the operation of the food law.

The enforcement of this law has called attention anew to the desirability of a Federal law relating to food products. In 1903, a shipment of alleged olive oil was refused admission into the United States because of its content of 20 per cent. of peanut oil. The next shipment from the same manufacturer consisted of four barrels of olive oil and one barrel of peanut oil. It could only be assumed that it was intended that the two oils should be mixed in this country after importation. It is also possible for importers to bottle or re-pack imported articles and label them in a manner that would not be permitted for importation. One illustration of this that came to our notice

some months ago was the following: An importation of French olive oil was labeled as a California product. It was not allowed to enter. It was found, however, that the same grade of oil was imported unlabeled and the label added in this country. Under the present law these practices cannot be stopped, as the Department has no jurisdiction after the importation of a shipment. Wherever the investigations of the Department suggest the possibility of such a practice, the authorities charged with the enforcement of the food laws of the State into which the importations are made are notified, in order that they may investigate and take such action as the case will warrant.

The analytical work connected with the enforcement of this law is not by any means confined to the analysis of samples from shipments inspected. It has been found necessary to analyze large numbers of samples of known purity and of commercial products for the sake of obtaining data for standards regarding classes of foods for which no standards exist. In such cases no practical results are possible except in the nature of the standards that have been adopted or are under consideration. At the same time, the data secured will enable the Bureau to enlarge its work in the near future and include a much wider range of foods than the articles now inspected. Owing to a recent extension of the work by the establishment of the new port laboratories, the Bureau is now inspecting a much larger number of shipments than has been possible heretofore. With our present organization a much larger volume of work will be disposed of during the next year than has been possible in the past.

The shipments inspected during the first two years of the enforcement of the law, from July 1, 1903, to July 1, 1905, are given in the following tabular statement:

Statement of Imported Food Samples Received by the Bureau of Chemistry and Results of Inspection Reported for the Period Beginning July 1, 1903, and Ending June 30, 1905.

Found contrary to Law	Wine	Meat	Olive Oil	Miscellaneous	Total
Admitted with a caution of being first offense	50	9	11	38	108
Released without prejudice to future decisions in similar cases	78	5	2	186	271
Admitted after the labels were changed to harmonize with the law	10	11	10	190	221
Required to be reshipped beyond the jurisdiction of the U. S. or destroyed .	46	5	23	15	89
Condemned but not disposed of	5	11	2	5	23
Total violation of the law .	189	41	48	434	712
Found to comply with law .	1097	196	622	949	2864
Total number of samples examined from invoices detained	1286	237	670	1383	3576
Samples taken from invoices not detained . . .	700	2	4	392	1098

ELECTROLYSIS OF GAS PIPES.

In discussing a paper on "High-pressure Gas Distribution of To-day," read by Mr. H. L. Rice before the meeting of the American Gas Light Association, at Milwaukee, Wis., on October 19, Mr. Frank S. Richardson related some experiences with electrolysis of gas pipes due to the current which escaped from a neighboring trolley railway. The power station for the railway is located at about the middle of the six-mile pipe line, and the pipe is connected to the trolley rail at this point in five places. About 600 feet of pipe has recently been removed opposite the power house on account of the damage which had been done before the pipe was connected to the rail. One length of pipe had 27 pits in it, and three other lengths were pitted so badly that they leaked. Formerly there was an insulated joint in the pipe line at intervals of 500 feet, but the pipe has recently been bonded with No. 4-0 wire, making the line a continuous conductor. Experience indicates that it is best to have the line free from insulated joints and to bond the rails wherever possible. Tests have shown that, due to the unavoidable potential drop in the rail portion of the electric railway circuit, difference in potential exists between the opposite ends of each insulating

joint and current will pass from one length of pipe to the next by way of the soil. Observations have furnished conclusive evidence that insulated joints will not keep the pipe from being damaged, and that the best method is to bond the pipe joints.

Mr. Theodore Bunker stated that a difference of potential as high as 25 volts had been found between the pipe line from Camden to Trenton, N. J., which is laid parallel to a poorly bonded electric railway. A heavy copper wire was run from the pipe to the power house and after three years of operation, when the pipe was uncovered, it was found that no damage had been caused by the electrolysis.

THE PRESERVATION OF NIAGARA FALLS.

It is very evident that public interest is being aroused for the preservation of the Falls of Niagara. The extent of the power development on the Canadian side, coupled with the eager efforts made to obtain extravagant franchises from the Legislature of New York, has directed attention to the conditions surrounding Niagara. President Roosevelt gives national importance to the subject by according it place in his annual message to Congress, and at a meeting of the Canadian Section of the International Waterways Commision, recently held in Toronto, the time was passed in discussing the policy which the Canadians will endeavor to follow in dealing with the important question of the Niagara power development and the preservation of the scenic beauties of the great cataract. Beyond question much will depend upon the powers of the commission to regulate the power companies already established.

Up to this time there has been no international regulation of the rights of power developments at Niagara, for it is only recently that the subject has been considered from this standpoint, it being clear that, separately, the State of New York and the Province of Ontario can hardly be relied upon to control the situation. Franchises on the Canadian side of the river are granted by the provincial government, while those of the New York side are granted by the State Legislature. A natural rivalry exists for industrial greatness, the tendency being to overlook the sentimental thought for the preservation of the scenic spectacle. New York State gets no revenue from the power development, while the commissioners of Victoria Park have said they expected the revenue from the Candian franchises to amount to $200,000 annually. It is time that a body, vested with powers from the federal government of both countries, should step in and regulate power matters at Niagara in the interests of the people on both sides of the border.—*Iron Age.*

Last year 33 steel steamers were launched at the various shipbuilding plants along the Great Lakes. Ten of these were from the yards of the Great Lakes Engineering Works of Detroit, 22 from the yards of the American Shipbuilding Company, and one from the yard of the Toledo Shipbuilding Company, Toledo, Ohio. Detroit had the greatest number of launchings, eight from the Ecorse yards of the Great Lakes Engineering Works and four from the Wyandotte plant of the American Shipbuilding Company.

(Stated Meeting, held Thursday, February 1, 1906.)

The Analysis of Dyestuffs.

By J. Merritt Matthews, Ph. D.

Head of Chemical and Dyeing Department, Philadelphia Textile School; Lecturer on the Chemistry of Textiles and Pottery, Franklin Institute.

The analysis of dyestuffs may be viewed from several points of departure. In the first place, a dyestuff may be considered as any other organic body and its analysis may have reference merely to the determination of the amounts of the chemical elements present in it, which, of course, are determined in the usual manner of organic analysis, which presents no difference in form from that ordinarily pursued. This character of dyestuff analysis has no importance to the dyer or textile chemist in the manufacture and synthesis of dyestuffs. After these few words concerning this form of analysis we will dismiss it without further consideration.

Another form of dyestuff analysis is one which has for its purpose the determination of the money value or tinctorial power of the coloring-matter; in other words, the determination of the actual amount of coloring-matter present in the sample. This character of analysis is of special importance to both the manufacturer of the dye for the purpose of obtaining products of uniform and standard strength, and to the user of the coloring-matter who is desirous, of course, of obtaining the full value of his money. There are two general methods by which the tinctorial power of a dyestuff may be determined. The first one, and the one which is of chief importance, is that of an actual dyeing test. This method of analysis is one necessitating a comparison with an accepted standard sample, or a comparison between several samples of the same dyestuff. Such a test is carried out in the following manner: Suppose,

for instance, that four samples of a dyestuff are submitted by different sellers to the chemist with certain quotations of price per pound. The chemist is to determine which of these samples is the cheapest one to purchase with reference to the amount of coloring-matter they may contain. It is of course presumed that the dyes are similar in character and are to be used on the same kind of fibre and by the same dyeing process, otherwise a comparison cannot be obtained. For purposes of the test, 0.5 gram of each of the samples is dissolved in about 200 cc. of boiling distilled water, and when solution is complete it is diluted to one litre with cold water. This solution will consequently contain 0.0005 gram of dyestuff in each cc. For acid dyes to be employed in the dyeing of wool, well scoured skeins of woolen yarn of 5 grams weight are to be used, and the test baths are prepared with 100 cc. of the dyestuff solutions, 20 per cent. of glaubers salt, and 4 per cent. of sulphuric acid, together with sufficient water to bring the volume of the bath to 300 cc. The percentages of chemicals are in terms of the weight of the wool dyed. The skeins are entered into these test baths at a temperature of 120°F., and the heating is so regulated as to bring the baths to the boiling point in a half hour; the dyeing is then continued for a further half hour with the baths at a simmer, and during the dyeing the skeins should be turned systematically from time to time. In order to obtain accurate results, it is important in these tests that the several skeins of woolen yarn employed are of the same kind of wool and that they weigh the same amount; also that the conditions of dyeing in the several baths are as nearly alike as possible; that is to say, the heating arrangements must be such as to permit of the several baths to be heated equally and uniformly, that each bath comes to the boil in the same time, and is maintained at that temperature for the same period of time.

After the dyeing has been carried out as indicated, the skeins are removed from their respective baths, the excess of liquor in the skein being squeezed back into the dyebath, and the dyed samples are well washed in cold water. Portions of the skeins are then dried and compared for color. The one showing the deepest color is taken as the standard by which to judge the others and is set aside for comparison. The other skeins are placed back in their respective dyebaths, further additions of

the dye solutions are added, and the dyeings continued until the color on each skein matches in depth with that on the standard sample, record being kept in each case of the amounts of dye solution added. The values of the samples are then inversely proportional to the amounts of coloring-matter required to yield the standard color. For illustration, let us suppose that sample No. 1 required 65 cc., sample No. 2 required 78 cc., and sample No. 4 required 105 cc. of their respective solutions to match the color of No. 3, obtained with 50 cc. of its solution. Then calling the value of sample No. 3 as 100, the relative value of No. 1 would be $50/65 \times 100 = 77$; that of No. 2 would be $50/78 \times 100 = 64$; and that of No. 4 would be $50/105 \times 100 = 47$. These figures give the relative coloring powers and the relative money values of the different samples, from which their true values may be easily calculated with reference to the prices per pound at which they are offered.

In the carrying out of this analysis a rather nice adjustment of color matching is necessary, and this requires the chemist to have an eye trained in this line of observation. As it often happens, the different samples of dyes do not possess the same exact tone of color; that is to say, one red dye may show a more bluish tone than another, or one yellow may be of a more greenish tone than another, etc. In such cases it is sometimes rather difficult even for the practised eye to determine when the color on one sample dyeing is of just the same depth as on the other. Another point to be observed is that when the dyeings on the skeins deficient in color are continued after the first matching, care should be taken to keep the volumes of the dyebaths as near as possible equal to 300 cc., by supplying the necessary water to make up for that lost in boiling, otherwise the concentrations of the baths become greater and greater, a condition which will lead to erroneous results. No further additions of either Glauber's salt or acid should be made to the baths, as these would also lead to a change in the conditions of the different tests.

In the case of substantive or direct dyes on cotton, the tests should be carried out in the same general manner, only skeins of cotton weighing 10 grams should be employed and the baths should be made up with the dyestuff solutions, 20 per cent. of common salt, and 1 per cent. of soda ash. In the case of basic

dyes on cotton, the skeins must previously be mordanted in the following manner: The necessary number of skeins are treated together in a bath containing 4 per cent. of tannic acid dissolved in sufficient water to conveniently work the material. The skeins of cotton are worked in this bath for half an hour at a temperature of 190°F., then immersed beneath the liquid and allowed to stand without further heating for two hours. The skeins are then removed, rinsed slightly, and worked for fifteen minutes in a solution containing 2 per cent. of tartar emetic at the ordinary temperature, after which they are well washed in several changes of water, when they are ready for dyeing. In preparing the dyebaths for basic colors, besides the dyestuff solution there is also added 4 per cent. of alum, and the dyeings should be started at a temperature of 100°F., and raised to 190°F. in half an hour, and maintained at that point for half an hour. When mordant dyes (alizarin colors and allied products) are to be dyed on wool, the test skeins should previously be mordanted together in a bath containing 3 per cent. of potassium bichromate and 4 per cent. of cream of tartar, treating the skeins at a boiling temperature for one hour, and then washing well in several changes of water, after which the skeins are ready for dyeing. It may be remarked that when mordating operations are required previous to the dyeing test, all of the skeins to be employed in the tests should be mordated simultaneously and together, for if the skeins are treated in separate baths with the mordants, it is likely that each skein will not have just the same amount of mordant as every other skein, a condition which would vitiate the dye tests.

When properly carried out this practical dye-test method of analysis is capable of yielding results accurate to within about three per cent., though the character of color being tested has much to do with the accuracy of the results; because the eye is sensitive to smaller differences with some colors than with others; for instance, it is very difficult to detect small differences in yellows, or in colors where yellow is the predominating factor, while it is comparatively easy to see such differences in intensity where the predominating color is blue or red.

Though the dye-test method of analysis appears to be the one best suited to the practical needs of the dyer and chemist, several chemical methods of analysis have been proposed from

time to time. In the analysis of acid dyes, it has been suggested to precipitate their solutions with a standardized solution of a basic dye, such as Night Blue. Such a method would also have to be a comparitive one, for each acid dye would possess a different titre in terms of the Night Blue; that is to say, it would be impossible to give the standard solution any absolute factor of colorimetric units, and the analysis would have to be conducted by determining the relative values of different samples of the same dye in terms of the standard solution of Night Blue. In fact, this method would not have the same scope of operation as would the previously-mentioned dye-test method; for in the latter method, samples of different red dyes, for instance, of the same color and dye class could be tested, whether these dyes were of the same exact chemical constitution or not; whereas with the chemical method, a true comparison could only be obtained between different samples of identical dyes. Another disadvantage to this form of chemical analysis is the fact that the end point in the titration is very difficult to obtain with any degree of accuracy or nicety, owing to the strong color both of the solution to be tested and the solution employed for titrating; in fact, it is always necessary to filter the liquid at each test for the end reaction, and it is usually very difficult to remove all of the precipitated color, even by careful filtration.

Another method of chemical analysis which has come into notice rather recently is the use of certain strong reducing agents for the purpose of titrating solutions of dyes, the end reaction depending on the decolorization of the dye solution. Sodium hydrosulphite has been employed for this purpose, but titrations with this reagent are difficult to carry out owing to the extreme ease with which it is oxidized by the air. To obtain results of any degree of accuracy the titration must be conducted in an atmosphere of same inert gas, such as carbon dioxide or coal gas. Furthermore this method also has the disadvantage of being limited to a comparison of different samples of identical dyestuffs. For the analysis of indigo samples, however, this method is a very good one, the solution of sodium hydrosulphite being standardized on chemically pure indigotine, and a form of burette being used, which allows of ready

titration without having the reagent at any time in contact with the air.

Another chemical method, based somewhat on the same idea as the preceding one, is the use of a solution of titanous chloride as the reducing reagent. This is a strong reducing agent, causing the complete decoloration of a large number of dye solutions, and in many cases giving a very satisfactory end reaction. The same precautions must be employed in the titration as mentioned in the case of sodium hydrosulphite. This method also has the same limitations as the preceding one in that it is only serviceable for the comparison of different samples of the same dye.

PRODUCTION OF STONE IN 1904.

A report on the stone industry in 1904 is among the recent publications of the United States Geological Survey. It is published as an extract from the volume of "Mineral Resources of the United States, 1904," and is intended for general distribution.

The total value of stone reported in 1904 was $74,200,360, which is a gain of $1,254,453 over the value of stone in 1903, when it amounted to $72,945,908 The corresponding gain in 1903 over 1902, when the figures were $69,830,351, was $3,115,557. In 1902 the gain over 1901, when the total value was $60,-275,762, was $9,554, 589; and in 1901 the gain was $12,267,023 over 1900.

In 1904, granite, marble, and limestone increased in value, while slate and sandstone decreased.

Granite showed the largest increase. In 1904 its total value, including that of trap rock, was $10,992,983; in 1903 it was $18,436,087, a gain of $7,443,-104 for 1904. The granite production increased from $15,603,793 in 1903 to $17,169,437 in 1904, a gain of $1,565,644; and the trap rock from $2,732,294 in 1903 to $2,823,546 in 1904, a gain of $91,252.

Sandstone, including bluestone, decreased in value from $11,262,259 in 1903 to $10,295,933 in 1904, a loss of $966,326. The value of bluestone included in the sandstone was $1,779, 457 in 1903, and $1,791,729 in 1904, an increase of $12,272. The sandstone figures decreased from $9,482,802 in 1903 to $8,504,204 in 1904, a loss of $978,598.

The value of marble increased from $5,362,686 in 1903 to $6,297,835 in 1904, a ain of $935,149.

This late output was valued at $6,256,885 in 1903, and at $5,617,195 in 1904, a loss of $639,690.

The limestone output remained nearly the same, being valued at $31,627,-991 in 1903, and $31,996,415 in 1904, a gain of $368,424 in 1904.

CLAY-WORKING INDUSTRIES IN 1905.

In reviewing the progress made by the clay-working industries in 1905, Mr. Jefferson Middleton, of the United States Geological Survey, notes that the year was unusually prosperous. There has never been greater activity in building.

Bricks.—In nearly every large city in the United States the demand for structural material, especially brick, was greater than the supply. In Greater New York the enormous consumption of brick drove the price up to $10 a thousand for common brick during the height of the season. What this means will be better understood when it is stated that only a few years ago brick of the same grade sold for less than half this price. Other great cities also consumed unusually large amounts of building brick, though strikes in some of them, notably the teamsters' strike in Chicago, interfered to some extent with the building trades. As a result of the immense consumption of brick along the Hudson River, in both New York and New Jersey, was the largest ever recorded. The same stimulus was felt at points in Connecticut and Massachusetts, as well as at points in New Jersey some distance from the Hudson River.

During the year the paving brick industry was in a flourishing condition, and returns will show a notable increase over the business of 1904. Brick pavement seems to be growing more popular in the smaller cities, and as the proper method of laying it is becoming better understood there is no reason why it should not prove entirely satisfactory.

The use of face or front brick seems to be increasing. This kind of brick is used now instead of stone on many of the largest buildings.

The output of fire brick naturally reflects the condition of the iron and steel industries, and as these were phenomenally prosperous in 1905, it may be expected that the production of fire brick in that year will show a large increase over that of 1904.

Pottery.—The pottery industry thrived during 1905. The price agreement was broken early in the year and caused some disturbance in the industry, but by the end of the year matters had so adjusted themselves that normal conditions prevailed. It is the general impression among producers that the products for 1905 will be greater that for 1904, but that the value of the output will be about the same. The importers of pottery during 1905 will probably show a falling off, possibly explained by the fact that the quality of the ware made by American potters is steadily improving. The prospects for 1906 in all branches of the clay-working industries seem to be very bright.

Clay.—In the clay-mining industry the conditions in 1905 were similar to those in 1904. The fire clay mined will naturally increase with the increase in the fire brick output. The potters seem to be unable to procure satisfactory suppies of American kaolin, although a considerable quantity of this material is used in paper making.

THE PRODUCTION OF PLATINUM IN 1904.

The war between Russia and Japan is probably responsible for the fact that the output of platinum in the United States increased from 110 ounces in 1903, valued at $2080, to 200 ounces, valued at $4160 in 1904. Owing to anxiety in regard to the fate of the platinum industry in Russia, the price of platinum rose about 10 per cent. during 1904. "It should not be understood," says Dr. David T. Day, of the United States Geological Survey, in a recent report on the production of platinum and allied metals in 1904, "that the slight rise of 10 per cent. in the price of platinum would serve as any great stimulus to the placer gold miners of the West who furnish the platinum products of the United States, for these miners are comparatively indifferent to a slight change in price. The scarcity of platinum and the consequent rise in price, however, led to much energy on the part of eastern smelters of platinum in urging upon the placer miners of the West the advisability of saving platinum in cleaning up the hydraulic mines. The increase thus effected is interesting as showing what is possible in the United States in the future."

In the opinion of Dr. Day, the outlook for increased production for the year 1905 is good, not only on account of the continued high price of platinum, but because of the investigation undertaken by the Geological Survey of the black sands of the Pacific Slope and of the increased knowledge thus furnished to the miners in regard to the value of the platinum and to simple means of saving it.

The world's total supply of platinum for the year amounted to about 300 kilograms, or 9625 troy ounces from South America, and 6000 kilograms, or 192,500 troy ounces from Russia. No production of platinum from Australia was reported. A slight product of both platinum and palladium from the Sunbury copper mines continues to come on the market, but it is not profitable to extract all of the platinum and palladium which these ores could furnish. Increased interest in the occurrence of platinum in hydraulic mines and dredges of the Fraser River is due principally to the fact that the natural alloy of iron and nickel previously found in Josephine County, Oregon, and in Del Norte County, California, has also been found in commercial quantities in the Fraser River at Lillooet. An interesting and new occurrence of platinum in place in Sumatra has been noted by Prof. L. S. Hundeshagen. All the American platinum came from California and Oregon, inasmuch as operations have been suspended in the Rambler copper mines, Wyoming, which furnished some platinum the year before.

The imports of platinum into the United States during 1905 showed a decline of more than 8000 ounces due to European control of the supply, which also, of course, aided the rise in price. The present prices are the highest that platinum has commanded in recent years.

This brief paper of Dr. Day's is published as an extract from the Survey's annual volume, "Mineral Resources of the United States, 1904." Copies may be obtained, free of charge, on application to the Director of the Geological Survey, Washington, D. C.

Book Notices.

Electricity in Every-Day Life. In three volumes. By Edwin J. Houston, Ph. D. (Illustrated.) New York: P. F. Collier & Son.

The three volumes, constituting this latest contribution to electrical literature, made by the author, may be unreservedly recommended to the non-professional reader, as a reliable source of information and instruction upon the almost numberless and various applications of electricity in daily life.

The author has spent many years of his life as a teacher, and this fact doubtless explains his mastry of the art of elucidating his facts and data so plainly as to bring even the most abstruse topics within the comprehension of the non-expert reader.

The present work is very comprehensive in its scopes, and it is no exaggeration to say that, as a popular exposition of the historical evolution and present state of the electrical arts, there is nothing in our literature to compare with it. W.

Sections.

Section of Physics and Chemistry.—*Stated Meeting*, held Thursday, February 1, 8 P.M. Dr. R. H. Bradbury in the chair.

Present, eighteen members and visitors.

The following officers were elected for the current year, viz.:—

President—Dr. R. H. Bradbury.

Vice-Presidents—Dr. H. F. Keller, Prof. G. A. Hoadley.

Secretary—Dr. E. A. Partridge.

Conservator—Dr. Wm. H. Wahl.

The first communication of the evening was read by Dr. J. Merritt Matthews, on "The Analysis of Dyestuffs."

Mr. H. Clyde Snook presented a communication on "The Use of the Induction Coil with the Walter Schaltung," and gave an exhibition and demonstration with an apparatus of this description.

Both communications were freely discussed. The meeting passed a vote of thanks to the speakers of the evening, and adjourned.

E. A. Partridge, *Secretary.*

Special Meeting, held Thursday, February 15, 8 A.M. Dr. Edward Goldsmith in the chair.

Present, thirty-four members and visitors.

Prof. A. J. Henry, U. S. Weather Bureau, read an illustrated paper, on Weather Forecasting from Synoptic Charts."

The thanks of the meeting were voted to the speaker. Adjourned.

E. A. Partridge, *Secretary.*

MINING AND METALLURGICAL SECTION.—*Stated Meeting*, held Thursday, January 25, 8 P. M. Mr. G. H. Clamer in the chair.

Present, twenty-six members and visitors.

The following officers were elected to serve for the current year:

President—James Christie.

Vice-Presidents—G. H. Clamer, A. E. Outerbridge, Jr.

Secretary—S. S. Sadtler.

Conservator—Wm. H. Wahl.

Dr. Wm. Campbell, of Columbia University, New York, read the paper of the evening entitled, "Some Notes on the Structure of Iron and Steel," profusely illustrated with the aid of photo-micrographs. The thanks of the section were extended to the speaker. Adjourned.

WM. H. WAHL, *Sec'y pro tem.*

ELECTRICAL SECTION. *Stated Meeting*, held Thursday, February 8th, 8 P.M. Mr. Thomas Spencer in the chair.

Present, twenty-six members and visitors.

Mr. E. D. Hays, representing the Cooper-Hewitt Electrical Co., of Philadelphia, gave an exhibition and demonstration of the Cooper-Hewitt Mercury Vapor Lamp.

This communication was followed by an exhibition and description of a series of electric heating and cooking appliances by Messrs. Walker & Keppler, of Philadelphia.

The meeting thereupon adjourned.

RICHARD L. BINDER, *Secretary.*

Franklin Institute.

(Proceedings of the stated meeting held Wednesday, February 21, 1906.)

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, February 21, 1906.

MR. JAMES CHRISTIE in the chair.

Present, forty-eight members and visitors.

Additions to membership since last report, fourteen.

In commemoration of the 200th anniversary of the birth of Franklin, the evening was devoted to an address by Dr. Edwin J. Houston, honorary member of the Institute and Professor Emeritus of Physics, on "Franklin as a Man of Science and Inventor."

The address will appear in due course in the *Journal.*

The speaker was accorded a unanimous vote of thanks, and the meeting was adjourned.

WM. H. WAHL, *Secretary.*

Committee on Science and the Arts.

(Abstract of Proceedings of the stated meeting held Monday, February 7, 1906.)

DR. EDWARD GOLDSMITH in the chair.

The following reports were adopted:

(No. 2365.) *Speed-Jack*, C. J. Reed, Philadelphia.

ABSTRACT: The invention is covered with five letters patents of the United States issued in 1904 and 1905, to the applicant.

A full description of the device with illustrations will be found in the *Journal* for November, 1904, to which reference is made for details of mechanical construction and operation.

Referring to the operative features of the apparatus the committee states in its report * * * "While the uses for the Speed-Jack under consideration are not exactly the same as those to which a variable speed countershaft can be placed * * * it is designed to accomplish the same result. * * * The jack tested by your committee gave excellent results under very trying conditions and appeals to us as being a thoroughly practical equipment, well suited to meet many of the conditions requiring mechanical speed control." The award of the John Scott Legacy Premium and Medal is recommended to C. J. Reed, the inventor. (*Sub-Committee*, Charles Day, Chairman; Kern Dodge, Chas. E. Ronaldson, Hugo Bilgram.)

(No. 2371.) *Friction Indicator*, Carl B. Weidlog, Sag Harbor, New York.

ABSTRACT: This invention is covered by letters patent of the United States, No. 741,087, Oct. 13, 1903, granted to applicant.

It relates to an improved indicator whereby the depth to which a hole is being drilled can be accurately determined, and whereby a group or number of holes can be drilled to the same or any specified depth.

The device consists of a bracket adapted to be secured to the bearing of a drill-bar, supporting, on ball-bearings, an arbor on which is mounted a circular disc of hard fiber having a circumference of precisely four inches. The ball-bearing itself is supported on a swivel, so that by means of a spring the hard fiber disc can be pressed against the spindle bar of the drill-press, to be set in motion by the downward motion of the bar.

By means of an index finger secured to the arbor and registering with a stationary dial, the distance of the downward motion of the drill can be read off. If a hole of a given depth is to be drilled, the index is set to zero when the drill is in contact with the work. As the drilling proceeds, the increasing depth of the hole is then registered on the dial. * * *

The device was thoroughly tested in the workshop of Mr. Hugo Bilgram, and his report of its performance which proved very satisfactory is attached as an appendix to the committee's report.

The report concludes with the statement that "the device is very useful for the purpose designed; it is well made, accurate in its registration, and a time saver. The inventor is awarded the Edward Longstreth Medal of Merit. (*Sub-Committee*, Chas. E. Ronaldson, Chairman; Hugo Bilgram).

(No. 2375.) *Quartz-Glass Mercury Lamp.* W. C. Heraeus, Hanau, Germany.

In the opinion of the sub-committee investigating this invention its main value consists in the introduction of Quartz-Glass as a material for the bulbs of mercury-vapor lamps and in the truly remarkable skill displayed in the production of these quartz-glass vessels.

As these features, in the committee's opinion, constitute a very considerable step in advance in the construction of mercury lamps, particularly for experimental purposes, the award of the John Scott Legacy Premium and Medal is recommended to be made to W. C. Heraeus, of Hanau, Germany, its inventor. (*Sub-Committee*, Harry F. Keller, Chairman; Thomas Spencer, W. J. Williams.)

(No. 2376.) *Rapid-Fire Gun.* Victor P. De Knight, Washington, D. C. (An advisory report.)

(No. 2381.) *Concrete Pile.* Alexander C. Chenowith, Brooklyn, N. Y.

ABSTRACT: This invention is covered with two United States patents, No. 791,076, May 30th, 1905, and No. 797,556, Aug. 22d, 1905, the former covering the product and the latter the process of manufacture.

The details of this invention will be unintelligible without the aid of illustrations. The publication, therefore, will be made in full in the *Journal* in due course.

The conclusions of the sub-committee are as follows: In view of the apparent novelty of the method, and of the strength and durability of the product the award of the John Scott Legacy Medal and Premium is recommended to be awarded to the inventor. (*Sub-Committee*, Lewis M. Haupt, Chairman; Louis E. Levy). W.